METALLURGIA

The British Journal of Metals

(INCORPORATING THE METALLURGICAL ENGINEER.)

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METALLURGIA

THE BRITISH JOURNAL OF METALS.
INCORPORATING "THE METALLURGICAL ENGINEER".

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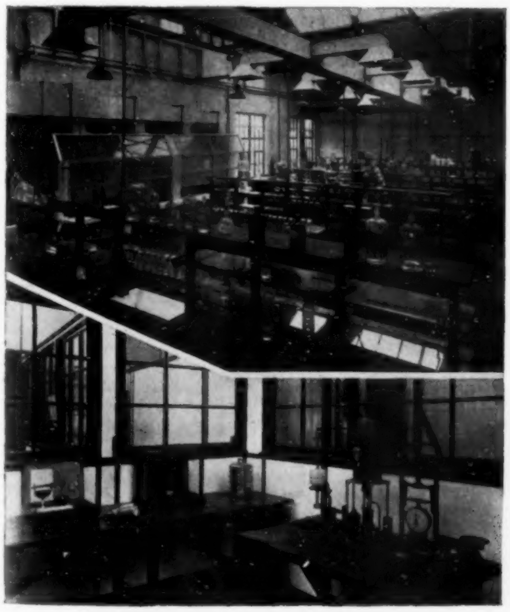
New Production and Research Laboratories

The march of industrial progress depends essentially on research ; it is necessary to provide a scientific basis for the development and maintenance of control of the quality of a manufactured product. This is particularly true in the manufacture of metals and alloys, which must preserve a high quality so that products in which they are used are reliable. This is the policy of High Duty Alloys, Ltd., whose new laboratories at their Slough Works are described in this article.

NO hit-and-miss methods can suffice to establish the control limits required at every stage in the production process, from the raw materials to the finished product, to maintain the quality of a product. Control of quality can only be successful when the manufacturing process is developed and maintained on a scientific basis, new developments can then be introduced in the process in the shortest possible time. Combining research with production not only enables new developments to find their way into production processes without undue time-lag, but it materially assists in preserving the quality of the various products within very narrow limits. Strict laboratory control of all products has long been the policy of High Duty Alloys, Ltd., and in keeping with this policy, a new laboratory building has just been completed at their Slough Works.

A general view of the chemical laboratory.

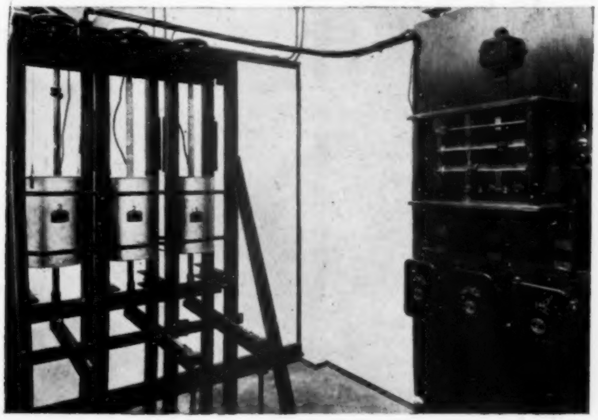


The sand-testing room.

These new laboratories, the fourth laboratory block to be built since the company's inception in 1928, are in a building entirely separated from the works, and cover an area of some 7,250 sq. ft. They have become necessary as a result of the increasing demand for high duty alloys of a reliable character. In addition to controlling the technical activities of High Duty Alloys Ltd., these laboratories will supervise the quality production of the associated companies, Magnesium Castings and Products, Ltd., and High Duty Bronze, Ltd.

The Chemical Laboratory

The chemical laboratory contains the very latest analytical equipment, and is necessarily a very large department, as every batch of virgin material and every cast of hardener alloy and finished "Hiduminium," "Magnuminium," and "Hidubronze" alloy is subjected to a complete quantitative analysis. It will accommodate more than 20 chemists and assistants, and at the moment is dealing with almost 600 separate estimations per day. This laboratory is divided into two compartments—the laboratory proper and the balance room. The former is a high, well-ventilated room, with an overhead forced draught fume-scavanging system running its entire length.

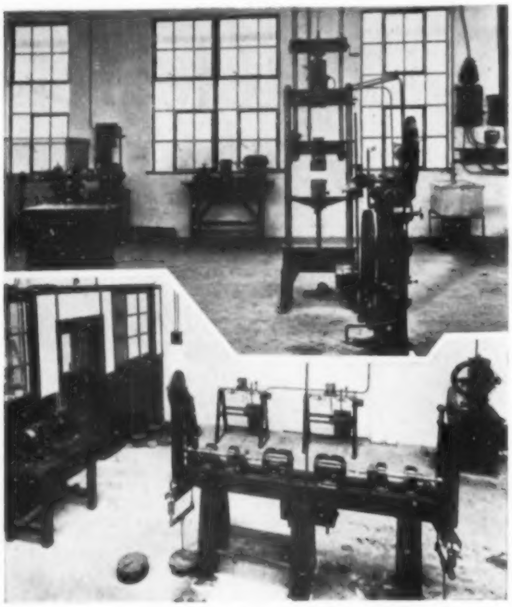


A separate room set apart for the creep-testing plant.

Equipment includes a spacious white-tiled fume cupboard, five large double-working benches evenly spaced across the laboratory, and further benches along two of the walls. The main benches have glass-covered central reagent shelves, sinks, and cupboard space is provided beneath both these and the wall benches. The latter are fitted with sinks and racks for washing and drying glassware, and also support a gas-fired combustion furnace and

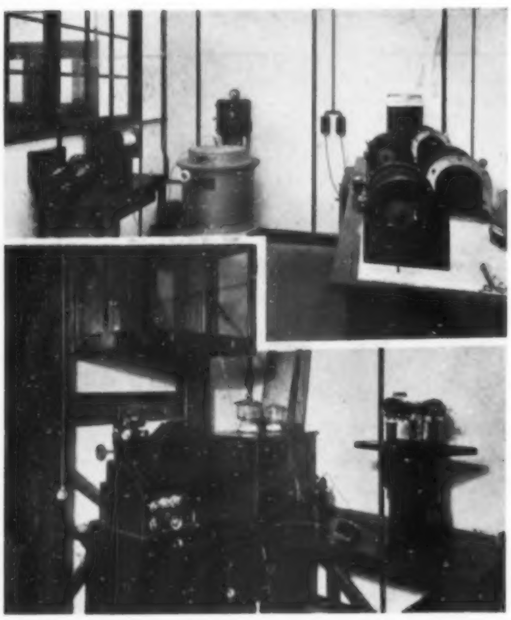
electric drying ovens. An electrolysis apparatus for copper estimation, calorimeters and the usual balance room equipment complete the apparatus at present installed.

Part of the research physical and mechanical testing laboratory showing salt-spray corrosion tank, 15-ton Amsler hydraulic universal testing machine, Arnold alternating bend fatigue testing machine and rotating fatigue testing machine.



Another part of the research physical and mechanical testing laboratory, showing the repeat impact fatigue testing machine, the N.P.L. and Amsler-Wohler fatigue testing machines and the Koch wear-testing machine.

Research heat-treatment room.



The metallographic room showing "Vickers" projection microscope and "Philips" X-ray spectroscope.

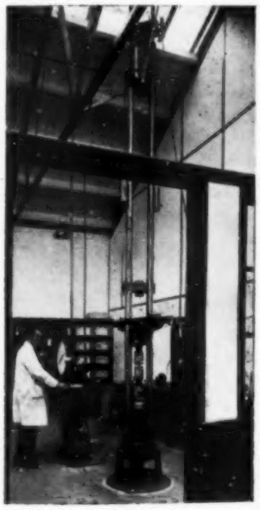
The Physical Laboratory

The production physical laboratory consists of several rooms, housing test-piece turning lathes, apparatus for testing moisture content, crushing strength, permeability, etc., of the sands used in the foundries, and the usual mechanical testing machines, including a new 30-ton Amsler hydraulic universal testing machine specially adapted for dealing with test-pieces up to a length of 10 ft. in both tension and compression. This department deals with approximately 200 tensile tests per day, and also controls the thermo-couple and other temperature indicating and recording apparatus throughout the three factories.

Research Laboratories

The research laboratories, which have received special attention in the laying down of this building, constitute one of the best-equipped industrial non-ferrous research departments in the country, and contain, or will contain when fully equipped, facilities for every useful form of testing known to non-ferrous metallurgy.

The largest room in this department contains at the moment various special physical and mechanical testing machines, including a 15-ton Amsler hydraulic universal testing machine for tensile, compression, bending, Brinell, and shearing tests, which by the use of a specially designed furnace can be carried out at any desired temperature. A battery of Amsler-Whöler and N.P.L. type fatigue testing machines, an Amsler repeated impact fatigue testing machine, an Arnold alternating bend testing machine, a Kochs wear testing machine, a sea-water spray corrosion tank, and a rotating fatigue testing machine for testing specially designed sand-cast test-pieces to compare the effects of casting and heat-treatment strains. This latter machine is also adaptable for testing bearing metals. Further equipment on order to complete the scope of this department includes an N.P.L.-Gough combined stress fatigue testing machine and a Haigh testing machine.



30-ton Amsler hydraulic universal testing machine designed to take test pieces up to 10 ft. in length.

The research foundry is equipped with gas-fired and electric resistance crucible furnaces, and a specially designed fluidity testing apparatus. Ample floor space is provided for sand and permanent mould casting for experimental purposes.

The heat-treatment room contains a Wild-Barfield electric furnace with centrifugal fan air circulation, and five small electric ovens. All these are thermostatically controlled, and are connected to automatic thermo-couple temperature recorders. This equipment is capable of carrying out accurate thermal treatments between room temperature and 1000° C.

The creep testing plant is contained in a separate room to facilitate accurate temperature control, and to eliminate draughts which might upset the delicate apparatus. This battery consists of three furnace units, each controlled by a potentiometric thermo-couple circuit acting through mercury switches. Extension of the test-pieces under load is measured by means of Martens mirror extensiometers and calibrated telescopes.

The macro- and micro-photographic department consists of a photographic studio, a dark room, a room for the preparation, polishing, and etching of specimens, and a large room containing a Vickers' projection microscope with a range of magnification of from 3 to 3,000 diameters, a Philips' Metallix X-ray spectroscope, and a prism diffraction spectroscope, and various miscellaneous apparatus, such as dilatometer, tensometer testing machine, and instruments for measuring diffraction diagrams, etc. The company is one of the first to instal X-ray apparatus, and

have on order now more modern equipment which will be installed in the next few weeks.

The remaining floor space is devoted to offices and a research library. The latter is a new feature, and is one which will be of invaluable assistance to the laboratories and the whole company in general. Under the direction of a trained science librarian, in addition to making the preliminary research investigation of published work, it is intended to extract and file all obtainable information on non-ferrous alloys, etc., and also to circularise departmental executives with any data which may be of interest to them.

It will be seen from the foregoing description that no effort has been spared by High Duty Alloys, Ltd., to provide themselves and users of their alloys with every possible detail of the chemical, physical, and mechanical characteristics of non-ferrous metals and alloys, and to guarantee that only the finest materials are despatched from their factories, a policy which in the past has earned for all the "Hiduminium" alloys a unique place in the respect and confidence of metallurgists, designers, and engineers in all industries.

Tungsten Carbide and Cobalt Cutting Material

By ARTHUR HASLAM

Developments in cutting-materials during recent years have revolutionised the work in the machine shop and have facilitated the machining of hard or tough materials that was formerly regarded as impossible. The latest material to be manufactured for this purpose on a commercial basis is tungsten carbide and cobalt. It is claimed to have remarkable possibilities, possessing strength, hardness, toughness, and the ability to take and keep a cutting edge.

WITHIN the present generation we have seen tool steel developed to a remarkable degree of efficiency. Tools for lathes, boring mills and planers make deep cuts in steel and iron at speeds that were unheard of when many machinists of to-day were in the apprentice stage of their education. And now a new step forward has been taken by the development of a combination of substances, which so far exceeds our present standards of cutting-tool practice as to promise another revolution. This combination is made up of tungsten carbide and cobalt. The remarkable characteristics of this combination have been known for some years, particularly in Germany, but the development of a method by which it could be manufactured on a commercial basis has been a matter of no little difficulty; this has now been accomplished.

In appearance the finished product resembles metals of the steel class, but it does not tarnish, and it offers a very strong resistance against the attack of chemicals. In using it for machine tools, a comparatively small piece of it is welded to the tool body. In the matter of strength, its modulus of rupture in a transverse or cross-bending test runs from 250,000 to 275,000 lb. per sq. in. of section, or about half the strength of high-speed steel.

Of all known substances, the diamond is the hardest and next to it is the sapphire. But the sapphire can be scratched by this substance, which thus gives it a rating of hardness next to the diamond. The strength, hardness, toughness, and chemical stability, together with the ability to take and keep a cutting edge, gives this material extraordinary possibilities, as compared with our present tool materials. But we have found that the performance of the material on the lathe and in the shop does actually exceed any reasonable predictions which might be based on a knowledge of these properties. This is doubtless due to two circumstances which are highly favourable to this material. It has no temper to be drawn by the heat generated, and it is actually much harder than the materials machined even at elevated temperatures, while steel tools are frequently softer.

The initial experience with a material having such remarkable properties is apt to mislead one into believing that it is capable of almost anything, but it, like other materials, has its breakdown point, first through deficiency in one property and then in another. But what it did accomplish gives promise that many things that are as yet not commercially machinable will one day be brought within its scope. For instance, in the production of fused quartz, it has been found advantageous to use moulds of carbon—the hard, abrasive variety. Many attempts proved that the best tool lost its cutting edge, and began cutting a taper soon after starting a cut on carbon. The difficulty involved in machining a hollow cylinder of carbon may be easily imagined. On putting tungsten-carbide-cobalt tools on this job, we found the cut made without tapering, and no wear of the tool. Commutators of electric machines are composed of alternate layers of copper and mica. The bearing surface of these has to be machined after assembly on the shaft. The mica is quite abrasive, and has always presented a problem to the machine shop, because the operation is one which must be carried out accurately. With high-speed steel a sacrifice must be made on this job, either in speed or in the finish of the surface, whereas the carbide tools cut through the mica without undue wear and give a smooth finish to the commutator.

Bakelite offers somewhat similar problems, and, on account of machining this material at high speed, diamond tools have been commonly used. But the diamond possessed one disadvantage which was overcome by substituting tungsten carbide and cobalt. If the part machined contained a metal insert, a special operation was required to recess this below the cut of the diamond, for if the diamond were to hit the metal at high speed, it would break off at once. Here the new substance tool necessitates no such special operation because it cuts both the bakelite and the metal insert. One of the most difficult jobs to do on cast iron with the usual tools is that of removing the surface layer, particularly if the surface contains sand, but tungsten carbide and cobalt handles such work with little difficulty. Even on annealed tool steel and wrought iron this new tool material came out of the test in every way satisfactory. In machining tests as well as on production, the use of tungsten carbide and cobalt as a tool material has brought about a decided increase in the cutting ability and the life of the tool.

Setting Diamond Dies in Monel Metal

Diamond dies for wire drawing have hitherto usually been set in steel, but an American company has discovered that the nickel-copper alloy, Monel Metal, is superior for this purpose. The company reports that Monel Metal "has the same shrinkage power and possesses a co-efficient of expansion practically identical with that of steel, and is, a better resistant to acid and alkaline corrosion than any of the common metals."

The Platinum Industry in 1935

By Charles Engelhard

WHILE it is too early to compile precise figures to illustrate the progress of the platinum metals in the year 1935, it can be definitely stated that consumption of these metals confirms the revival of all of the industries in which they are used. Developments during the latter part of the year were particularly significant. Through July consumption was normal, but there occurred a relatively large increase in demand in August, and this demand continued at a good level. Indeed, not only did it surpass the preceding months, but those of the corresponding months of 1934.

Canada continued as the leading producer, being followed in order by Russia, South America, and South Africa. Consumption of all platinum metals, including palladium, will probably be close to 275,000 ounces.

Part of the upturn in consumption may be attributed to improvement in the spirit of the jewellery trade. Evidently by mid-summer the trade became convinced that the winter market for fine jewellery was likely to reflect other signs of better business conditions, and sustained buying indicated that this opinion was reinforced as time progressed. Thus the usual seasonal upturn which ordinarily occurs in August, climbed to a level higher than that of 1934.

The continued activity of the chemical industry has led to several new developments and to further inquiry for platinum catalysts and laboratory equipment. Platinum-clad material for chemical apparatus is again being discussed in the industry. This follows closely the introduction of nickel and other clad materials. There appears to be no reason why industry should not avail itself of the corrosion-resistant properties of platinum in this economical form.

In dentistry the use of platinum and palladium alloys continues to grow. To the æsthetic advantages of their neutral colour are added the sanitary considerations that they make for surfaces which are non-tarnishing and easy to clean. In addition, careful consideration by members of the dental profession of the qualities of precious metals has led to a further appreciation of the properties of platinum and palladium and their alloys. Restorations made of these metals are not so hard that they will crack or erode natural teeth, and they can be worked by the dentist after they are made, so that the restoration will fit perfectly.

Rhodium found increasing use as a finish for reflectors and for the protection of silverware from tarnish. Establishments were opened in New York, Philadelphia, and Chicago for job plating of rhodium, and "rhodanizing" of decorative silver pieces is being offered as a service by leading department and jewellery stores throughout the United States.

Industrial uses of the platinum metals continue to advance or hold their own. Among those in which platinum has become well established are the rayon manufacturing industry, which uses platinum gold spinnerets for handling caustics, and the electrical field, where platinum points in magnetos provide a high degree of reliability for airplane motors and the like.

Palladium leaf is finding wider acceptance in diverse fields, ranging from pure decorative art to bookbinding. A number of artists have used palladium leaf as a white material comparable to gold leaf in screens and panels, and a method for applying coloured pigment to the metal surface has been developed.

The Copper Development Association has issued a useful little book on brass and other copper alloy wire and wire products. It includes mechanical properties and other data for copper alloy wire, together with examples of familiar applications which should prove useful in dealing with production problems. It is very neatly prepared and of a handy size. Copies may be obtained from the offices of the Association, Thames House, Millbank, London, S.W. 1.

Forthcoming Meetings

INSTITUTION OF MECHANICAL ENGINEERS.

Feb. 21. The First Report of the Pipe Flanges Research Committee. Presented by Dr. H. J. Gough, M.B.E., F.R.S., M.I.Mech.E.

Mar. 6. "The Importance in Practice of the Lower Yield Point in Mild Steel," by Prof. B. P. Haigh, M.B.E., D.Sc.

INSTITUTION OF AUTOMOBILE ENGINEERS.

Mar. 3. Joint Meeting in which several other Societies will participate, on "Rail Cars." The Symposium will comprise four papers: "The Engine," by Mr. H. D. Bush; "The Transmission," by Major W. G. Wilson; "The Chassis and Body," by Mr. C. J. Hyde-Trutch; and "Operation," by Mr. Julian Tritton. To be held in the Hall of the Royal Geographical Society, Kensington Gore, London, S.W. 7.

INSTITUTE OF METALS.

Mar. 11–12. Annual General Meeting in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. 1.

BIRMINGHAM SECTION.

Feb. 21. "The Fabrication of Metal Structures."—Open Discussion.

Mar. 5. "Methods of Analysis for Impurities in Copper, etc.'

LONDON SECTION

Mar. 5. "Patent Law—with Special Reference to Non-Ferrous Metals," by G. S. W. Marlow, B.Sc.

NORTH-EAST COAST SECTION.

Mar. 17. "Foundry Costing,' by S. G. Homfray, B.A., and R. A. Balderston.
Joint Meeting with Newcastle Branch of Institute of British Foundrymen.

SCOTTISH SECTION.

Mar. 9. "The Centrifugal Casting of Non-Ferrous Metals," by F. W. Rowe, B.Sc.

SHEFFIELD SECTION.

Mar. 13. Annual General Meeting.

SWANSEA SECTION.

Mar. 17. "Metallurgical Control and the Bronze Foundry," by A. F. Murphy, M.Sc.

MANCHESTER METALLURGICAL SOCIETY.

Mar. 19. "Refining of Metals by Sodium Carbonate," by N. L. Evans, B.Sc.

Mar. 4. "Fusion Welded Pressure Vessels," by S. F. Dorey, D.Sc., Wh.Ex.

INSTITUTE OF BRITISH FOUNDRYMEN.

BIRMINGHAM BRANCH.

Mar. 4. "The Applications of Pulverised Fuel," by H. E. Cookson.

EAST MIDLANDS BRANCH.

Feb. 22. "Non-Ferrous Castings," by A. Logan.

LANCASHIRE BRANCH.

Mar. 7. Ten-Minute Papers by New Authors.

BURNLEY SECTION.

Mar. 10. Annual General Meeting.
"The Influence of the Various Metalloids on Cast Iron," by D. Malone.

LONDON BRANCH.

Mar. 4. "The Possibilities of the Electric Furnace in the Cast Iron and Brass Foundry," by A. C. Robiette.

NEWCASTLE-ON-TYNE BRANCH.

Feb. 22. "Foundry Products Through the Microscope," by E. B. Ellis.

Mar. 17. "Foundry Costs," by S. G. Homfray and R. A. Balderston.
Joint Meeting with the Institute of Metals.

SCOTTISH BRANCH.

Mar. 14. "Castings," by W. Machin and M. C. Oldham.

FALKIRK SECTION.

Feb. 29. "Foundry Coke," by H. L. Riley.

SHEFFIELD BRANCH.

Feb. 21. "Sand and Shot Blasting," by J. H. D. Bradshaw.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.

Feb. 25. "The Corrosion Problem in Steel," by Dr A. McCance.

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The Main Product of the Steel Industry

SO much attention has been directed to the many types of alloy steels developed during comparatively recent years, that the mass products of the steel industry is sometimes overlooked. The steel product most universally used is plain carbon steel, and the many purposes for which it is employed have set up exacting and varied requirements which steel manufacturers have endeavoured to meet through painstaking work in the laboratory, the steel department and the rolling mill. Physical defects in carbon steels which formerly existed have largely been eliminated by improved melting practice, new methods of teeming and a better knowledge of the casting of ingots. Rolling processes have been vastly improved and reduction is effected at much higher speeds than formerly. Large sums have been expended by the steel industry in replacing obsolete equipment, and in developing new methods of production and research to produce the high quality carbon steels available to-day.

It is true that the development of alloy steels has had a profound influence on industry in general and engineering in particular. Their introduction resulted from an endeavour to improve the qualities of ordinary carbon steel and to provide engineers and other users of steel with materials which were not only strong and hard, but were at the same time tough, ductile, resistant to shock and impact, and possessed good fatigue values. They were developed, in response to demands of engineers for metals and alloys with special properties, after intensive scientific research and, after successful commercial tests, have gradually been introduced into industry. But in the main these steels are used for special purposes, where superior strength, wear, corrosion or heat-resisting qualities are necessary; they are used for parts which occupy key positions in machines or structures and form a relatively low proportion of the total steel used. In such industries as aircraft and, to some extent, in automobile construction the use of carbon steels for constructional purposes may be more limited, these are however, exceptions to the general rule.

In automobile construction the highest physical properties of the best-known straight carbon steels were taxed to their utmost to meet and successfully sustain many old forces intensified in new combinations. These requirements created a need for physical properties beyond the capacity of the best-known combinations of carbon and iron in solution, nicely adjusted by heat treatment, and the alloy steels were developed. But while the service requirements of the most vital parts of an automobile can be satisfied by the greater physical properties of alloy steels, the requirements of the majority of parts are still within the limits of straight carbon steel. In many other industries straight carbon steels play a more important part and are used almost entirely.

Although there is considerable controversy regarding processes of steel manufacture—whether by the basic, acid or electric processes—the bulk of straight carbon steels produced is manufactured in the basic open-hearth furnace. It is claimed that the steels produced by this process are not inferior to steels produced by other processes. It must be remembered, however, that steel is required to do the job for which it is intended, safely and for a reasonable length of time; for the majority of purposes economic considerations demand that it should be cheap, and while the steel industry has given considerable attention to improving the quality of its primary product economies in operation have been effected to keep costs low.

It is a noteworthy achievement that while raw materials have shown a tendency to rise, increased production coupled with improved quality of the finished product has been possible without a corresponding rise in price. Improved technique in manufacture and greater production has offset not only increased raw material costs, but has also increased personnel costs. Even during the worst years of the depression progressive firms in the iron and steel industry were making diligent searches for economies in operation and putting into operation reconstruction schemes to effect economic production. One of the most important factors towards this end has been the more efficient utilisation of fuel made available and required in the various processes of iron and steel manufacture. But in addition to the installation of modern coke ovens to deal with the fuel problem, much of the obsolete plant in this country has been modernised or replaced. Blast-furnaces, open-hearth furnaces and rolling mills, have been, or are being, brought up to a high state of efficiency, and the iron and steel industry can be congratulated on the effective manner in which reorganisation has been tackled.

The demand for increased accuracy and improved quality of the general forms in which carbon steels are marketed is fully appreciated in the rolling mill, where new equipment and improved technique have been responsible for great progress in recent years. Each section of the industry has benefited from a close study of the problems associated with the variation in the character of the materials rolled and substantial improvement has been made not only in regard to accuracy and quality, but also in the speed of production. Much new equipment has been installed or is in progress of manufacture, of which mention may be made of the new four-high reversing cold-strip mill for Messrs. Whitehead Iron and Steel Co.; the blooming mill at the new works of Guest Keen Baldwins Iron and Steel Co., Ltd.; the reconstruction of the rod mill at the works of the Templeborough Rolling Mill Co., the large reversing mill at the Briton Ferry Steel Company's works; the continuous rod mill at Colvilles, Ltd., etc. These of, course, only represent a few instances of developments in rolling mills, but they are representative of the efforts of the industry to adjust production to meet modern conditions, and it is noteworthy that by far the greater amount of development is concerned with the main product of the steel industry—ordinary carbon steel.

We mourn the passing of King George V. We salute our new King, Edward VIII. May his reign be long and happy and may it be attended by the prosperity of his people.

Elektron Magnesium Alloys

THE use of Elektron has increased so rapidly during the past few years, and its applications have extended so widely that its manufacture in this country has become a matter of urgent necessity. For this reason, Magnesium Elektron, Ltd.—an associated company of Messrs. F. A. Hughes and Co., Ltd., the introducers of Elektron—have secured a site at Clifton Junction, near Manchester, where a plant for the production of Elektron is now in progress of erection. This plant will have an output sufficient to meet all present demands, and its capacity will be maintained at a level sufficient to cover future needs, thus rendering users entirely independent of imported supplies. It is anticipated that this plant will be in full production by September.

Elektron, as many readers are aware, is a magnesium alloy with a specific gravity of 1·81 to 1·83. It is interesting to recall that magnesium was first isolated by the English chemist, Sir Humphrey Davy, in 1808. One hundred years passed before the problems of production were satisfactorily solved, but the Elektron group have now completely mastered the fabricating technique.

Elektron has made great progress in many engineering industries. Its high strength/weight ratio, resistance to fatigue and freedom from embrittlement in service are qualities which have rendered it of inestimable value for a wide variety of purposes. In the aircraft industry, the magnesium alloys have become of major importance in view of their light weight—which is approximately 50% less than the weight of the aluminium alloys similarly employed. So widely is it used, in fact, that practically every machine in the air to-day incorporates some vital part made in these alloys.

The most outstanding applications of Elektron in the manufacture of aero engines are for crankcases, valve-gear cases, carburetter bodies, induction casings and for many components in the oil-circulating ignition and petrol supply systems. In aircraft construction it is used for landing-wheels, chain guards, axle blocks, control wheels, cowling, sheet formation, etc. In automobile and commercial vehicle construction manufacturers have found it of great assistance in improving one of the most important factors in automobile engineering—the power/weight ratio. In addition, its remarkable machining properties facilitiate high-cutting speeds which would appear to be limited only by the machine-tool capacity. Many engine and gear box components are now made of Elektron. It is also largely used for many parts of the chassis and axle assembly. In the electrical industry Elektron is particularly suitable for the outer casings of traction motors, motors used in aircraft and for portable tools. It is also being adapted for high-tension switchgear components where a low inertia loading is desirable.

In the general engineering industries the applications of Elektron are many. For the components of portable machinery and machine tools of all kinds, textile machinery, cigarette-making machinery, etc., where a metal of light weight, combined with great strength, is required, it possesses advantages over other alloys. An indication of its adaptability may be had in its use for deep sea diving apparatus. Such apparatus has reached a depth of 200 fathoms where the pressure is 260 lb. per sq. in. With continued development in industry, new uses will be found for these alloys.

The Institute of Metals Annual General Meeting

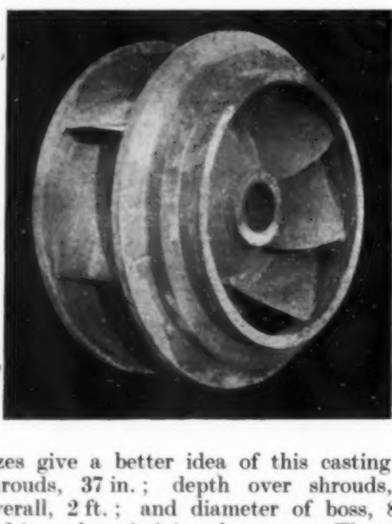
The twenty-eighth annual general meeting of the Institute of Metals will be held in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. 1, on March 11 and 12. In addition to an address by the President, the programme includes a number of papers for presentation at technical sessions held each day; these are on the following subjects:—"The Physical Properties and Annealing Characteristics of Standard Nickel Silver Alloys," by M. Cook, M.Sc.,Ph.D.; "Experiments on the Electrical Resistance of Copper and Some Copper Alloy Wires," by C. Blazey, M.Sc.; "Plastic Deformation and Age Hardening of Duralumin," by Major P. L. Teed; "The Influence of Light on Electrode Potential and Corrosion Phenomena of Certain Non-Ferrous Metals," by Professor C. O. Bannister, M.Eng., and R. Rigby, B.Eng. Ph.D.; "A Deep Drawing Test for Aluminium," by A. G. C. Gwyer, B.Sc.,Ph.D., and P. C. Varley, M.A.; "The Effect of Molten Solder on Some Stressed Materials," by Austin G. Wesley, O.B.E., M.Sc.; "The Hot Tinning of Copper: The Attack on the Basis Metal and its Effects," by E. J. Daniels, M.Sc.; "Influence of Surface Cuprous Oxide Inclusions on the Porosity of Hot-Tinned Coatings on Copper," by W. D. Jones, M.Eng., Ph.D.; and "An Electrolytic Test for Zinc Coatings on Wire," by S. C. Brittio, M.

Metallic Wear

In the evening before this annual general meeting there will be held in the Hall of the Institution of Mechanical Engineers a discussion on metallic wear. The meeting will continue from 7·30 p.m. to 10 p.m., Dr. Harold Moore, C.B.E., being in the chair. The discussion will be opened with a paper by Dr. H. W. Brownsdon entitled "Metallic Wear," which reviews some of the major factors involved in metallic wear in the presence of lubricants and indicates a method by which they can be quantitatively assessed. As the problems involved interest not only metallurgists but also engineers, physicists and chemists, speakers representing these groups of workers are expected to set forth their views in the discussion. Invitations have been extended by the Council to the members of the Institution of Mechanical Engineers, the Institution of Naval Architects, the Institution of Automobile Engineers, the Iron and Steel Institute, and the Royal Aeronautical Society; all others interested in the subject will be welcomed.

Stainless Steel Impeller

The accompanying illustration shows a stainless steel impeller casting recently made at the Teesdale Steel Foundry of Messrs. Head, Wrightson and Co., Ltd. The impeller is for a 36-in. V.S. pump for a power station. It carries double vanes, and weighs 9¼ cwt. The following



A stainless steel impeller 37in. diameter, weighing 9¼ cwt.

sizes give a better idea of this casting: Diameter over shrouds, 37 in.; depth over shrouds, 10¾ in.; depth overall, 2 ft.; and diameter of boss, 8½ in., splayed to 28⅜ in., where it joins the vanes. The vanes are seven in number on each side, and are 0·625 in. in thickness, tapering to ¼ in. thick. The super-stainless steel used is practically non-corrosive in sea-water, and the tensile tests, after the material was fully softened, were 41·6 tons per sq. in., elongation, 49·0% on 2 in., with 180°—1 in. × ¾ in. bend unbroken.

Modern Developments in Cold Rolling Mills

By
C. E. DAVIES,
A.M.I.MECH.E.

In the limited scope of these notes the author has confined his consideration to a general review of up-to-date mill designs, with reference to representative examples of mills which have fulfilled present-day requirement in cold-rolled strip and sheet production, and also to show the possibility of further development towards ever greater efficiency, without any revolutionary change in basic design.

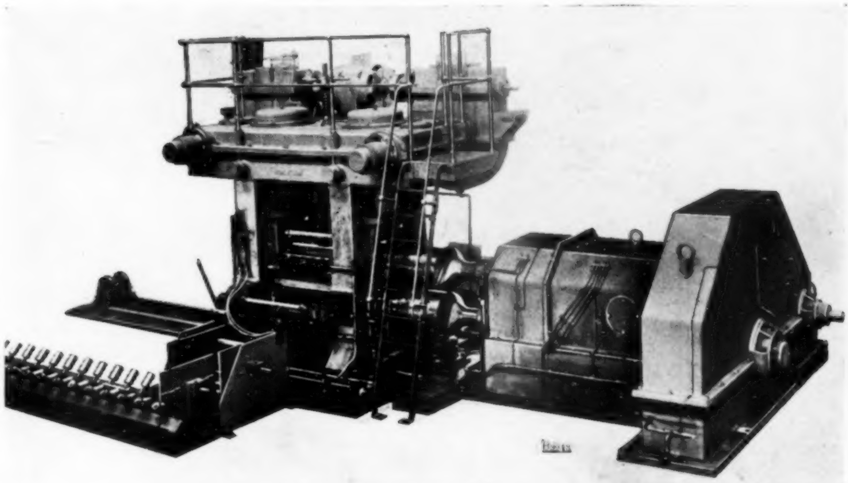


Fig. 8. High speed finishing mill for strip 26 in. wide. Rolls 18 in. × 32 in.

IN the previous article on cold rolling mills* reference was made to a reversing mill, sometimes preferred for intermediate and finishing passes, such as is shown in Fig. 8. This was a mistake as the mill described was shown in Fig. 7.

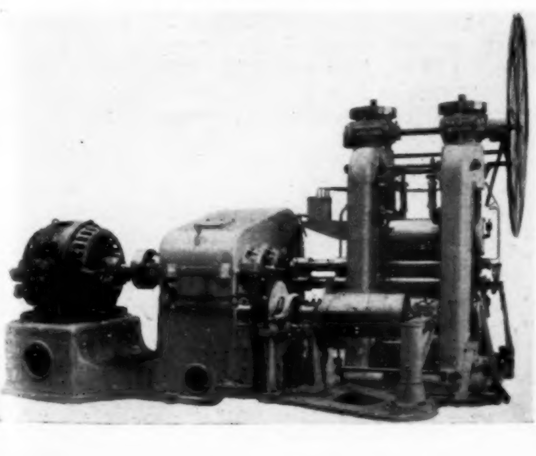
Fig. 8 is shown above, and was described in the penultimate paragraph in column 1, page 81, of previous article. This mill is probably the largest high speed two-high mill in Europe, with rolls 18 in. diameter, 32 in. face, a variable speed motor drive is provided to give rolling speeds from 200-400 ft. per min. The roll adjustment is operated by electric motor, and the mill is equipped with automatic coiling equipment, mechanical feeding, automatic coil ejector, etc. The coiler is driven by a separate motor giving constant and controlled strip tension. The design being representative of the most up-to-date wide strip mill, which has proved highly efficient for finishing strip up to 26 in. wide.

Cold-strip Mills for Steel

In the cold-steel strip mill, it is certain that the four-high mill is rapidly becoming the most favoured type, and is undoubtedly a most efficient mill for a wide range of gauges and widths. The alternative cluster (or six-roll mill) is now generally considered inferior and less convenient in practice to the four-high and, with few exceptions, those firms who have tried both types have pronounced definitely in favour of the simpler four-roll mill.

* *Metallurgia*, January, Vol. 13, No. 75, pp. 79-81.

Fig. 9.—A high speed four-high mill for handling strip up to 16 ins. wide.



Apart from other considerations the fact that the four-high mill has been proved satisfactory and most efficient at the highest economical rolling speeds, 300 ft. per min., and higher, has placed this design well to the fore as a high production cold-strip mill. Not only is it capable of effecting the maximum reductions per pass at high speeds, but the accuracy and uniformity to gauge product fulfils the most exacting requirements.

The two-high mill has, however, still an important and essential place in the steel-strip mill; firstly, for relatively narrow strip in heavier gauges; and secondly, for light finishing work or "skin pass" on all widths and lighter gauges, which work can be accomplished in the modern two-high strip mill at extremely high speeds, 350–450 ft. per min. being now by no means unusual. An example of high-speed four-high mill design has already been described in the earlier part of this article, dealing with non-ferrous strip mills and is illustrated in Fig. 1. The most popular size of mill of this type for steel strip up to say 10 in. wide, reducing from about 0·100 down to 0·010 and lighter gauges has working rolls 6 in. diameter, with backing rolls 14 in. diameter; pinions and reduction gearing are enclosed in a cast-iron gear case, with shafts running in roller bearings and the drive is most conveniently applied by a variable speed motor, giving a convenient range of rolling speeds from 100–300 ft. per min. A larger mill of the same general design is shown in Fig. 9. This mill has working rolls 7 in. diameter with support rolls 15 to 16 in. diameter, and is capable of handling strip up to 16 in. wide.

Whilst generally four-high rolling mills are becoming essential units in the steel-strip mill, there are several alternative methods of operating these, the relative advantages of which depend on individual requirements. These may be summarised as follows:—

(1) Independent non-reversing mills, for small output in a varied range of width and gauge.

(2) Continuous tandem trains, consisting of a number of (usually four-high) mills suitably placed and each driven by variable-speed motors with automatic speed control of

Fig. 10.—Four-high reversing mill designed for steel strip.

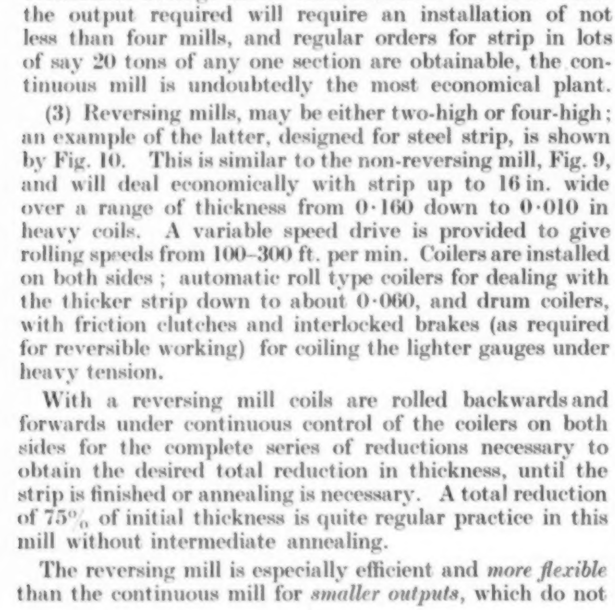
each mill. Such an installation is probably the most efficient plant for a regular and considerable output in a limited range of product and has the advantage that the finishing mill can run at an extremely high speed, giving maximum output, whilst the first stand is running more slowly. In this way the gearing can be provided so that the loads on each motor can be equalised and the most economical average motor load obtained. In cases where the output required will require an installation of not less than four mills, and regular orders for strip in lots of say 20 tons of any one section are obtainable, the continuous mill is undoubtedly the most economical plant.

(3) Reversing mills, may be either two-high or four-high; an example of the latter, designed for steel strip, is shown by Fig. 10. This is similar to the non-reversing mill, Fig. 9, and will deal economically with strip up to 16 in. wide over a range of thickness from 0·160 down to 0·010 in heavy coils. A variable speed drive is provided to give rolling speeds from 100–300 ft. per min. Coilers are installed on both sides; automatic roll type coilers for dealing with the thicker strip down to about 0·060, and drum coilers, with friction clutches and interlocked brakes (as required for reversible working) for coiling the lighter gauges under heavy tension.

With a reversing mill coils are rolled backwards and forwards under continuous control of the coilers on both sides for the complete series of reductions necessary to obtain the desired total reduction in thickness, until the strip is finished or annealing is necessary. A total reduction of 75% of initial thickness is quite regular practice in this mill without intermediate annealing.

The reversing mill is especially efficient and *more flexible* than the continuous mill for *smaller outputs*, which do not justify the installation of a tandem train of three or four mills, and where the range of widths and gauges handled is continually changing, and is capable of production of accurate strip at a low cost. Similar and larger mills are being installed suitable for rolling strip up to 24 in. and 30 in. wide. An example of high-speed two-high finishing mill for lighter reductions is shown by Fig. 11. This mill is especially suitable for "Skin" pass rolling, and operates at speeds up to 450 ft. per min. The rolls 10 in. diameter are mounted to roller bearings.

Fig. 11.—High-speed two-high finishing mill for light reductions.



Sheet Rolling.—Space does not permit dealing fully with the modern sheet-rolling mill, but for sheets in both steel and non-ferrous metals the large four-high mill is now generally accepted as the most efficient plant, in fact, in the case of steel in its harder qualities and alloys the economical production of thin width sheets would be scarcely possible without the use of mills of this type and in the case of brass and copper many such mills have already been installed and have proved to be capable of at least five times the output of the older two-high sheet mill, besides giving a more accurate product, with uniformity of gauge across the width of sheet. Less frequent annealing is also obtained, and the total reduction in production costs secured is very considerable.

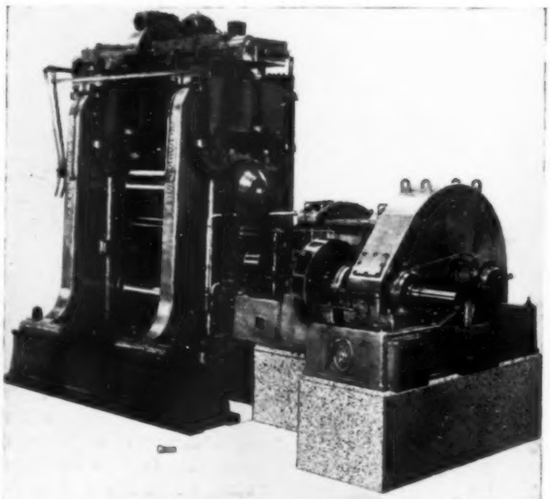


Fig. 12.—A large four-high sheet mill for sheet up to 4 ft. wide.

A large four-high sheet mill for sheet up to 4 ft. 0 in. wide, is shown in Fig. 12. This mill has working rolls 14 in. diameter, with large support rolls, the diameter of which may be from 28–40 in. diameter, according to the class of sheet rolled. These powerful mills, capable of exerting a roll pressure of 1,600–2,000 tons for reducing wide sheets in hard metal and alloys, are now frequently provided with special equipment for roll changing, similar to that shown in Fig. 7. Further, in order to overcome the difficulty of entering the sheets between the rolls set for a heavy reduction pneumatically operated feeding mechanism is fitted. In the case of specially well-finished sheets in both steel and non-ferrous metals, the two-high mill with friction-driven top roll is still considered to be superior to the four-high mill.

The conversion of such heavy four-high sheet-rolling mills for working on the strip-sheet process mentioned above requires only the provision of suitably powerful coiling equipment, with the necessary auxiliary flattening and shearing machines, but as indicated the rolling of sheet metal in the form of long heavy coils can only be adopted with economy on the basis of a very large output, and for this country development on these lines will probably tend to the installation of reversible mills in single units, rather than to tandem continuous trains as are favoured in the States.

Corrosion Resistance of Aluminium and Standard Aluminium Base Alloys

By P. MABB

Development in the manufacture and application of aluminium alloys has been rapid during recent years; one of the main factors which have contributed to this progress is the high corrosion resistance of many alloys. In this article the author reviews this important aspect and compares the corrosion resistance of aluminium and standard aluminium base alloys.

ALUMINIUM and the numerous alloys in which it is the major constituent are popular metals entering the sphere of every engineering industry on account of manipulability, reasonable strength in relationship to weight, good appearance, and appreciable resistance to corrosion. Owing to the advantages offered by this series of metals, both in saving of weight and economic mass production of components by such processes as die-casting, and so on, they have been widely employed, often with little regard to the service conditions obtaining, to the selection of the most suitable alloy from the range available, and to the behaviour of this alloy under these conditions. This has led to quite a number of failures, or partial failures, particularly from the corrosion point of view, so that aluminium, once regarded as one of the best of corrosion-resisting metals under the various atmospheric conditions encountered is now viewed by many with suspicion and often regarded as requiring protective finishes akin to those essential for the plain irons and steels. This attitude is a too severe one; aluminium *is* an exceedingly useful corrosion-resisting material, and among its many alloys there are several that fall little short of the base material itself in this respect. Providing due regard is given to the alloy composition, and to its quality with respect to technique of fabrication, materials may be selected possessing the desired mechanical characteristics, machinability, or castability, to suit most purposes, and still retain repute for resistance to corrosive attack. At the same time, simple finishing treatments conferring additional protection can be resorted to when extreme conditions of service have to be withstood without detriment to original characteristics of the material. It is proposed to give a short review of the common alloys available, with particular attention to their resistance to corrosion, and brief mention of methods of protection.

Commercial Aluminium

Aluminium itself, in the form of sheet, rod, tube, and sections, probably commands the major portion of the field of light metals. Normally, it is purchased as 98% minimum purity, extraneous elements being mainly iron and silicon. It can be hardened by cold working, and only responds to heat-treatment in the form of annealing. It answers the customary machining and fabrication processes, for which purpose it may be obtained in three tempers—soft, half hard, and hard. In the soft condition it is capable of a remarkable degree of drawing. The needs of the electrical industry for a material for conductors, for bus-bars, wires and tapes, and in particular for a material for the electrodes of electrolytic condensers, has made available an aluminium of 99½% minimum purity. This offers a useful material in non-electrical applications, where advantage is taken of its even greater immunity from corrosion than that possessed by the 98% purity metal.

Plain aluminium is not exactly an easy material to cast, and to assist in rendering it more manipulatable, one of the early advances was the incorporation of zinc as an alloying element. Unfortunately, this promoted hot shortness, a defect which was corrected by the addition of copper. With the developments of more recent years, aluminium-copper-zinc alloys have been relegated to the background, although still of importance where free machining properties, either of castings or of rod, etc., are essential. A typical composition for the latter purpose is 10 to 13% zinc, 1 to 2% copper, 0·5% maximum silicon, 0·2% maximum manganese, 1·0% maximum iron.

Where hardness is a prime feature in the as-cast state, copper is introduced as the alloying constituent, the hardness increasing with the copper content. 8% and 12% copper content are the most common alloys, and hardness values range from 100 to 140 V.D.N., as compared with values from 70 to 100 for many other common aluminium castings as cast.

Heat-Treatable Alloys

The first heat-treatable alloy produced was Duralumin, an alloy of 3·5 to 4·5% copper, 0·5% magnesium, 0·2 to 0·5% manganese, 0·5% maximum silicon, 0·8% maximum iron. The chief attribute of this material is strength in wrought forms, with susceptibility to annealing which permits of forming operations, and subsequently response to a normalising heat-treatment which imparts stability and maximum strength. The hardness in the fully annealed condition is of the order of 50 V.D.N., while in the normalised condition it should be in the neighbourhood of 120 V.D.N. It is the silicon constituent in the presence of magnesium and copper, which are precipitated in the form of silicides during normalising, and during the subsequent 24 hours that enables duralumin to be heat-treated.

TABLE I.

COMPOSITIONS OF TYPICAL COPPER-SILICON ALLOYS.

Sample No.	1	2	3	D.T.D. 84.
Composition %—				
Copper	6·35	4·62	3·25	8·0 max.
Silicon	1·13	1·53	3·05	2·5 „
Iron	0·68	0·70	0·30	0·8 „
Aluminium	91·84	93·15	93·40	—

Quite a number of proprietary alloys have appeared, and are in use both as castings and in sheet form, which contain copper and silicon. A number of these are given in Table I., which also includes the composition of the Airboard alloy D.T.D. 84. Nos. 1 and 3 are analyses of castings, while No. 2 is a material available for castings and in sheet, rod, wire, and tube forms. While they are not compositions which would be specifically stipulated nowadays, they are combinations which may be offered in response to tenders.

From the point of view of fluidity in casting, a plain aluminium silicon mixture offers advantages, and is very popular for this reason. Up to 15% silicon is common, 12% being a good average. The alloy suffers from the disadvantage of relatively large grain growth when produced as sand castings, and due to this, castings may offer planes of mechanical weakness as well as relatively corrodible areas. To overcome this shortcoming, modification treatments of the molten metal have been introduced into the casting process, and the so-called "modified" silicon alloys which result are fine-grain in structure.

With the advantages of nickel, evidenced particularly in

the development of alloy steels, stainless steels, nickel brasses, etc., it is not surprising that this alloying element has been pressed into service in the sphere of light alloys. Some of the first castings were produced in Germany, and a very suitable composition was found to be 5% copper, 3% nickel, 2% silicon. A range of alloys from widely different sources are given in Table II. The nickel exerts a refining influence on grain size, the alloys are exceedingly good with respect to freedom from blow-holes, while mechanical strength is higher than average, with good toughness and ductility.

TABLE II.

TYPICAL ANALYSES OF EARLY COPPER-NICKEL-SILICON ALLOYS.

Sample No.	1	2	3
Origin	German	Belgian	English
Composition %—			
Copper	4·5	3·5	4·1
Nickel	3·0	2·1	2·9
Silicon	1·7	2·7	4·9
Iron	0·4	1·1	0·8
Manganese	Traces	Traces	0·03
Aluminium	90·4	90·6	87·3

Leading from these early nickel alloys, Y alloy and the R.R. series of heat-treatable alloys appeared. The nominal composition of " Y " is 4% copper, 2% nickel, and 1·5% magnesium, with the remainder aluminium. This was mainly developed for properties at high temperatures, elastic properties, with good resistance to atmospheric and marine corrosion. The R.R. series comprise a number of alloys of aluminium base with copper, nickel, magnesium, silicon, and titanium as alloying constituents. In the respective alloys, these elements range from: Copper, 0·5 to 2·5%; nickel, up to 1·5%; magnesium, 0·1 to 5·0%; silicon, 0·2 to 2·5%; and titanium up to 0·2%; iron may be present up to 2·0%, and manganese to 0·15%. Improved corrosion resistance, by virtue of the very low copper content, high fatigue resistance both cold and hot, good ductility, high hardness and yield-point, fine grain size and absence of blow-holes, and, of course, amenability to heat-treatment, including stability after annealing, are the outstanding virtues of these materials.

Aluminium-Magnesium Alloys

Of relatively recent innovation are the magnesium and magnesium-silicon alloys of the aluminium series. A number of these are available, and they fall within the range of 0·5 to 7·0% magnesium and 0·1 to 0·75% silicon. Typical members of this group are a nominal 7% magnesium alloy, a 3 to 6% magnesium alloy, and a 1 to 2% magnesium alloy. An alloy of 0·5% magnesium and 0·75% silicon is comparable to duralumin in so far as it is responsible to thermal treatments, although temperatures and time vary considerably from those established for duralumin. The straight magnesium series are good cold-working alloys, available in wrought forms, including sheets down as low as 0·003 in. They possess good resistance to corrosion, superior to duralumin.

TABLE III.

TYPICAL ANALYSES OF ALUMINIUM MANGANESE ALLOYS.

Sample No.	1	2	3
Origin	American	English	English
Purpose	Diaphragms	Diaphragms	Panels
Composition %—			
Manganese	1·48	1·25	1·53
Silicon	0·37	0·26	0·19
Copper	0·05	0·01	0·02
Iron	0·68	0·37	0·71
Aluminium	97·42	98·11	97·55

Aluminium-Manganese Alloys

An aluminium manganese alloy is of interest in so far as it is not new, having been used extensively for diaphragms of speech transmitters on account of its initial hardness, but it has since earned reputation in new spheres—namely, for panelling of motor-car bodies. Typical analyses are presented in Table III., and it will be seen that the manganese content ranges about 1½%. Besides an increase in tensile strength and hardness, it is found that the manganese constituent rather improves upon the corrosion resistance of the 98% commercial aluminium. Incidentally, the behaviour of manganese here is analogous to its influence upon magnesium in the electron series of light alloys.

Corrosion Resistance

In selecting aluminium or a light alloy for a specific purpose, the particular composition chosen will depend to some extent upon whether in the wrought or cast form. Even so, usually there is quite a range from which the alloy may be drawn for general purposes. In some cases, selection may be indiscriminate, but, on the other hand, where corrosion resistance is of paramount importance, full consideration should be given to the variety of alloys available in order to secure best immunity. This particularly applies where bare metal surfaces are unavoidable for reasons of cost, design, or appearance. All of these metals carry a similar appearance, at least when compared in similar physical states—that is, rolled, cast, sand-blasted, etc.,—yet they may behave very differently when subjected to corrosive influences. Some effort has been made in technical literature, or in trade publications, to draw a distinction between various classes of alloys with respect to their resistance to corrosion, but where this has been done, it has usually been in terms of trade names or brands, and not with respect to generic compositions.

The repute achieved by aluminium for high corrosion resistance is due to the fact that it exceedingly rapidly becomes coated with a film of natural oxide, which, furthermore, self-heals as quickly as it is ruptured. It is thus automatically provided with a protective film which safeguards against ordinary atmospheric attack and against any corrosive influences which do not dissolve or remove it. Foreign inclusions in the surface weaken this protection in giving local lack of continuity. Impurities or alloying elements likewise tend to reduce the corrosion resistance of pure aluminium. Some constituents exert an influence only in so far as they break continuity, others increase the corrosion rate because they themselves are more readily attacked, while, again, still others exist which exert an added deleterious effect in so far as they are highly electrochemically electronegative to aluminium. Silicon belongs to this first group, magnesium is a typical example of the second, while copper represents the third category. Actually, such theoretical considerations are largely borne out in practice. However, in common with all other metals, the rapidity or extent of attack is largely governed also by physical condition of the surface and metallographic structure of the mass. Thus, highly polished and well-rolled surfaces are obviously superior to matted surfaces or to those exhibiting bad rolling defects. Again, coarse crystallisation in castings may set up paths of weakness, which may cause intergranular corrosion and promote disintegration.

Nickel as an alloying element finds wide application in modern light alloys, being introduced along with other constituents for procuring increased tensile strength at high temperatures and resistance to shock. From the electrochemical point of view, it may be expected to increase corrosion rate somewhat, although not nearly so seriously as copper. On the other hand, no such effect is experienced in practice in the copper-silicon alloys in which it is most used, but largely because it is relatively inert in itself, and on account of the pronounced action it exerts in producing grain refinement, it generally improves the immunity of these alloys.

Aluminium being a high electropositive element, demands that great care be exercised in design towards ensuring that bimetallic contacts shall be of such nature that they do not give rise to an unnecessarily high potential difference. Probably the greatest disparity arises in this respect between aluminium (or its light alloys) and copper or copper-rich alloys—*e.g.*, brass or phosphor bronze. Brass fixing screws should never be employed, and use should be made

of zinc-coated steel if aluminium alloy screws or rivets are inadequate for strength. When structures are such that assembly of aluminium to one or other of these metals is unavoidable, the harmful effect should be minimised by a suitably thick coating of bituminous or similar paint at the junctures.

Testing Corrosion Resistance

One of the simplest ways of testing these alloys in the laboratory is by means of the salt-spray test. A standard procedure is to submit panels, supported on glass shelves or rods, to the mist produced by atomising 20% salt solution by means of a blast of compressed air at ordinary temperatures. The panels are washed in cold water and wiped with a soft cloth once a day. Results quoted below were obtained in this manner.

A panel of commercial aluminium, showing on analysis 0·29% iron and 0·31% silicon as impurity, corroded slightly along the freshly cut edges on the first day; in four days slight whitish stains appeared on the surfaces; in three weeks corrosion was more general, but depth of attack very light. The appearance of the specimen at the end of this period is reproduced in the photograph, Fig. 1A.

A panel of aluminium 1½% manganese alloy as used for motor-car bodies behaved very similarly to the aluminium specimen, except that attack was rather slower, corrosion was more isolated, and less general at the end of the three weeks' period, indicating a slight superiority. This material analysed was sample No. 3, Table III.

Rolled sheet of the magnesium class, representing two popular varieties, showed up rather less well than commercially pure aluminium, and again, the higher magnesium content material proved to be comparatively inferior to the lower magnesium content alloy. Two alloys tested analysed as follows :—

	(a) %		(b) %
Magnesium	6·85	..	1·50
Silicon	0·40	..	0·71
Copper	0·12	..	Traces
Iron	0·65	..	0·59
Manganese	0·36	..	0·33

Under salt-spray test, material "A" developed superficial white stains on the first day, and a few isolated patches of corrosion in four days. These gradually extended and at the end of three weeks the bright surface was obscured by a general white deposit, which had not unduly penetrated the surface. The condition of this specimen is photographically reproduced in Fig. 1B. On the contrary, sample "B" was unaffected by the first day's exposure, and developed only a few whitish stains in isolated patches in four days. At the end of the full three weeks these patches had extended generally, but for the most part the attack was only superficial, corrosion pits being shallow and very isolated, although rather worse than for the pure aluminium sheet.

A 12% copper casting of the following analysis was tested :—

	%
Copper	11·00
Silicon	0·33
Iron	0·60

This was fairly extensively attacked on the first day, and rather badly in four days. Pitting was severe in three weeks, white incrustations, marred by reddish brown patches, being thick.

Regarding the plain silicon alloys, castings representing the 12% silicon content material in the normal condition (a) and in the modified condition (b) were subjected to the test. "A" contained 14·0% silicon and 0·30% iron, while "B" contained 12·7% silicon and 0·26% iron. "A" showed little discernible attack in one day, a few corrosion spots in four days, more generally distributed in one week. In three weeks it was fairly badly pitted. In the case of "B" the specimen was generally covered with white corrosion spots in three weeks, but pitting hardly perceptible.

The corrosion of duralumin (of the usual composition,

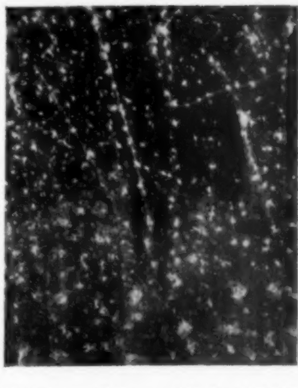


Fig. 1A.—Commercial aluminium after three weeks exposure to salt-spray test. × ½

Fig. 1B.—Commercial aluminium-magnesium alloy sheet after three weeks exposure to salt-spray test. × ½

4% copper, low silicon, manganese, and magnesium) varied somewhat with the thickness of the sheet, thin specimens deteriorating much more rapidly than thicker panels. Attack was definite in all cases on the first day. After four days heavy corrosion was apparent on the thin specimen (0·004 in.), while the attack on the thick specimen (0·375 in.) had extended considerably without penetrating deeply. In three weeks, the thin material was split and corroded to holes, while the thick sample was definitely pitted and comparatively heavily corroded. It should be noted that the thin specimen was more severely strained, due to cold-working, than the thick sheet. Fig. 2A depicts the condition of the 0·004 in. material after one week.

The low copper silicon alloys of the type covered by specification D.T.D. 84 were represented by a casting of the analysis given in Table I., sample No. 3. This specimen was attacked immediately, marked rusty-white deposits formed in four days, which had extended to cover the casting completely in the full three weeks' period, and were attended by extensive pitting.

The nickel-containing group were represented by two castings of similar composition—viz. :

	"A." %		"B." %
Nickel	1·45	..	1·10
Copper	2·02	..	2·22
Silicon	0·77	..	0·78
Manganese	0·10	..	0·12
Iron	0·87	..	1·27
Magnesium	—	..	0·52
Titanium	—	..	0·10

Specimen "A" was attacked all over in the first day, whereas specimen "B" was only slightly attacked and had only corroded to the extent of "A" after seven days. In the full three weeks, "A" was very badly pitted, but was superior to the low copper silicon alloys. "B" was markedly superior, presumably due to the modifying effects of titanium and to casting technique.

Additional Safeguards against Corrosion

Although it has been shown that aluminium possesses good resistance to corrosion, and that alloys are procurable which likewise show great immunity to attack, there are many occasions when the natural protective film is inadequate and additional safeguard has to be provided. These circumstances include those where abnormal conditions of atmosphere are encountered, those where virtually complete permanence is required, as well as those where artistic effect demands colouring in some manner for matching-up purposes. The available modes of protection may be resolved into the following four groups :—

1. Electroplate coatings.
2. Paint or other organic film.
3. Chemical oxidation.
4. Electrolytic oxidation.

Electro-plating can be satisfactorily carried out on aluminium base metals, and while employed in specific

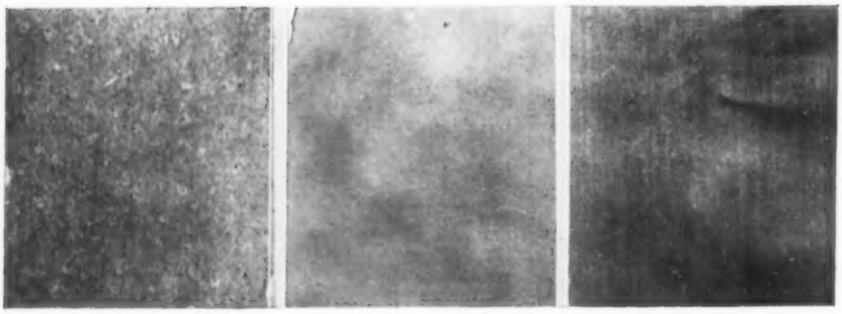


Fig 2a *Fig 2b* *Fig 2c*

Fig. 2A.—0·004 in. duralumin strip after one week exposure to salt-spray test. × ½

Fig. 2B.—0·004 in. duralumin strip, anodised by Alumilite process, after three weeks exposure to salt-spray test. × ½

Fig. 2C.—0·004 in. duralumin strip, sprayed one coat of bakelite oil varnish, after three weeks exposure to salt-spray test. × ½

cases, is not so widely adopted as the other means enumerated. The process is not easy, and is distinct from those for common metals, such as iron or brass, in demanding special attention to surface preparation if the plating is to adhere at all. Surface preparation entails scrupulous care in cleaning and degreasing, followed by a " metal dip." For the latter, a ferric chloride solution containing free hydrochloric acid is a popular one, it being employed hot, immersion being extended till gassing ceases, and whereby a film of iron is deposited on all surfaces. Work is washed and passed straight to nickel-plating, after which the desired electro-plate coating is applied. Obviously, chromium is the only logical metal to use for the latter, and, properly applied, the combined chromium nickel finish gives a finish of good permanence, excellent lustre and appearance, as well as improving surface hardness.

Paint and other applied organic media are evidently more manipulatable from the shop point of view than electro-plate coatings, although meticulous care in degreasing is still essential, particularly when cellulose vehicles are concerned. When aluminium castings or components are matted by sand-blasting or straight graining with the object of improving surface appearance, and additional protection by one of the superior methods, cannot be considered, a one-coat application of even clear cellulose lacquer should not be omitted, as this gives protection against minor handling. For real protection by simple finishes in such cases, a one-coat application of a colourless " synthetic " medium is exceedingly serviceable. This can be air-drying or baking, " glyptal " or " bakelite " base. In Fig. 2A a panel of 0·004 in. duralumin after salt-spray test was shown. Fig. 2C shows a panel of the same material, sprayed with one coat of air-drying colourless bakelite oil varnish, after subjection to the test for three weeks. Two or three corrosion spots only developed at discontinuities in the film, which averaged 0·0005 in. thick. The film was dry in eight hours from the time of application, but was allowed 48 hours in which to stabilise before test.

In general, where coloured pigmented paints or enamels are demanded, the most critical feature is the priming or undercoating. A red oxide or chromate base oil primer of tested adherence and flexibility is universally suitable. On the other hand, if an aluminium-like appearance is desired, aluminium cellulose media adhere extraordinarily well.

Chemical Processes

Several chemical processes have been developed for enhancing the protective properties of the natural oxide film. These are naturally oxidation processes, and the principal one is that termed the M.B.V. method. This consists in immersing the previously degreased work in a solution comprised as follows :—

Sodium carbonate (anhydrous)	5%
Sodium chromate (anhydrous)	1·5%
Water	Remainder

The operating temperature is 90–100° C., and the immersion period from 3–5 mins. ; water washing and drying follows. Where such hot solutions cannot be operated, the following mixture is employed at 30–40° C., the immersion period being extended to 30 mins. :—

Sodium chromate (anhydrous)	5%
Sodium carbonate (anhydrous)	1·5%
Caustic soda	1·0%
Water	Remainder

Again, where structures are of an unwieldy nature and cannot be immersed, they may be treated with a paste applied by brush or cloth. The composition of this is as under :—

Sodium chromate (anhydrous)	30%
Sodium carbonate (anhydrous)	12%
Caustic soda	12%
Water	46%

From 10 to 15 mins. contact is allowed, and the paste then slushed off with water.

The film produced by this chemical method affords an amazing increase in protective value on practically all the aluminium materials. It is not a particularly hard film, but this shortcoming can be minimised by immersion in a 3–5% solution of sodium silicate at 90° C. for 15 mins. Peculiar colour effects may be produced, which can be a serious drawback ; treated duralumin usually acquires a delicate mother-o'-pearl, but sometimes becomes blackened. This blackening tendency exists when aluminium alloys containing high percentages of copper are treated. Aluminium silicons become a dark purple. M.B.V. films possess no value from the viewpoint of electrical insulation. In conjunction with single-coat lacquer finishes, the chemical treatment can be a valuable adjunct to protective finishing processes.

The finishes which approach most nearly to the ideal for aluminium and its associates are the electro-chemical or anodic treatments. Two are well established in this country, the Bengough and the Alumilite methods. The most marked difference between these is the superior value of the latter from the viewpoint of electrical insulation, this being from five to ten times higher than with the former. Also may be claimed slightly easier operating for the Alumilite process.

The Bengough process (patented) uses 3% chromic acid as electrolyte, working temperature being 40° C. The work, thoroughly pre-cleaned, is made the anode, and is subjected to a voltage rise from 0 to 40 volts D.C. gradually over a period of 15 mins., 40 volts being maintained for 35 mins., then raised in 5 mins. from 40 to 50, and maintained there for 5 mins.

The Alumilite process (patented) employs sulphuric acid solution as electrolyte, usually about 15% strength, working temperature being 18 to 20° C. The voltage is fixed, being 10 to 15 volts D.C. The time may be varied up to an hour.

Graphite cathodes are used for the Bengough process, and lead for the Alumilite. Manipulation is similar for both, except in so far as mentioned above. Essentials are perfect contacts at work and bus-bars, disposition of the work for the avoidance of gas-locks, provision of agitation, cooling and temperature control, and provision of exhaust systems to handle the fumes and spray caused by heavy gassing.

Both types of film give excellent resistance to corrosion.

They are capable, in the condition upon leaving the vats, of being dyed or pigmented in many pleasing colours (except white), and selection may be made to cater for colours having resistance to heat or light, as may be required. They are hard and, particularly in the case of Alumilite films, flexible and abrasion resistant.

The application of these anodic processes is only restricted by alloy composition, the limiting factor being the presence of large percentages of heavy metal constituents or high silicon. In the latter case it means a discoloration to a purplish brown, while heavy metals—for example, copper, if exceeding 5%—give numerous points of weakness which mitigate against the protective value of the film.

Again referring to the series of photographs Fig. 2, that in Fig. 2B is anodised duralumin, finished by the Alumilite process after three weeks salt-spray test. The specimen was completely unaffected by these accelerated test conditions.

The above treatment of the subject has of necessity been exceedingly brief. With the very marked increase in consumption of aluminium, and of its alloys, and the exceptionally wide field in which they can be applied, render their protection against corrosion a matter of serious import, if their sphere of application is not to be seriously restricted. In the above has been indicated the manner in which a rational selection may be made of wrought or cast forms, with both mechanical properties and resistance to corrosion in view. Furthermore, the means of providing additional protection have been mentioned. In discussing the diverse range of alloys and their characteristics, it has provided a means of judging what compositional type to select, and further, from its behaviour under corrosive conditions, the need or otherwise of providing protection can be assessed. Moreover, the most suitable or convenient form of protective coating can be chosen from the narrow range indicated, with due regard to means available, production cost, and service conditions to be fulfilled. Finally, it may be mentioned that anodising offers a means of treating sheet and strip prior to blanking or forming, thus eliminating many awkward situations that would otherwise have to be solved if the finished article had to be treated, realising, of course, that the problem of the cut edge exists. It can aptly be added that the drawback of an " unfinished " cut edge, with external and internal surfaces of the formed component finished, is oft-times less serious than the somewhat analogous case in electro-plate finishing, where the interior surfaces are unfinished through poor throwing power.

Rail Steel and Rail Wear

By L. SANDERSON

Misunderstandings occasionally arise regarding the advisability of using a steel made by one or another process, particularly is this true of steel for railway rails, and in this article steels produced by different methods are discussed in relation to their use for rails.

THE steel manufacturer finds, in the course of his work, that many of his customers, even the most important, sometimes possess an inadequate understanding of the materials they buy. They often fail to understand the reason for the employment of a particular process, and why steel made by that process should not be compared with material made by an entirely different method, from the point of view of price and suitability.

Misconceptions frequently arise, for example, in connection with steel for railway rails. It is not always understood that there is a difference between rails of steel made by the Siemens open-hearth process and those of steel made by the Bessemer basic process. Siemens Martin steel rails cost more than Bessemer basic steel rails, yet it remains a fact that there are many more Siemens Martin rails used than Bessemer basic rails. Obviously, there is a perfectly sound explanation of this fact. On the other hand, there is the Bessemer acid process, which is more attractive than the basic.

The majority of specifications allow the manufacturer to choose for himself whether he provides rails made by either of these steel-making processes (*i.e.*, the Siemens or the Bessemer acid). It must be remembered that by Bessemer process is henceforward meant the Bessemer acid, and not the Bessemer basic process. There is a vast difference between the steels made by these two latter methods, the acid steel being much higher in quality than the basic. The primary reason for the greater employment of Siemens Martin steel for rails is simply that there are greater facilities available for its production, more works with the necessary plant being in existence.

The Bessemer acid steel process calls for a pig iron with an extremely high degree of purity so far as sulphur and phosphorus are concerned, the heat necessary for the process being procured by the combustion of the silicon contained in the pig iron. The process is primarily in operation in Cumberland, on the West Coast, owing to the fact that the ore there mined is exceptionally pure. The rails made from steel manufactured by this method are excellent, having hard-wearing qualities unexcelled by any other rails of similar steel.

Other steel makers not having such a pure ore to draw upon, are compelled to employ less pure varieties, and adapt their plants accordingly, so that the number of Siemens, basic open-hearth, or basic Bessemer steel producers is greater than that of the acid Bessemer steel producers.

BRITISH STANDARD ANALYSES FOR SIEMENS AND BESSEMER STEELS.

STEEL MADE BY THE OPEN-HEARTH ACID PROCESS.

Element.	Acid. Rails with Carbon Content, 0·45–0·55%. %	Rails with Carbon Content, 0·50–0·60%. %
Carbon	0·45–0·55	0·50–0·60
Manganese	0·90 (max.)	0·80 (max.)
Silicon	0·15 „	0·10–0·30
Phosphorus	0·07 „	0·06 (max.)
Sulphur	0·07 „	0·06 „

STEEL MADE BY THE BESSEMER ACID PROCESS.

Element.	Acid. Rails with Carbon Content, 0·40–0·50%. %	Rails with Carbon Content, 0·45–0·55%. %
Carbon	0·40–0·50	0·45–0·55
Manganese	0·70–1·00	0·90 (max.)
Silicon	0·15 (max.)	0·10–0·30
Phosphorus	0·075 „	0·07 (max.)
Sulphur	0·07	0·06 „

In the acid Bessemer process the steel is manufactured in blows of about 15–20 tons, as against 50–100-ton heats in the Siemens process. The former allows, therefore, of a more uniform pouring heat. A test sample can also be taken at more frequent intervals, which means a smaller tonnage of finished rails per test. The tables on the following page show a comparison of analyses and tests on rails made by the open-hearth acid and the Bessemer acid processes.

Either process gives a satisfactory rail. Wear on rails is, however, governed by considerations other than the quality of the steel. The care and attention given to the foundations and the ballasting of the track, the standard of maintenance insisted upon, and the design and condition of rolling stock, all have a considerable effect, and should receive careful attention. If there are curves on the track, it may sometimes be advantageous to employ manganese steel rails instead of ordinary steel, on account of the high degree of rail wear at such points.

A COMPARISON OF ANALYSES AND TESTS ON RAILS MADE BY OPEN-HEARTH ACID AND THE BESSEMER ACID PROCESSES.

Test No.	Marks on Specimen and Cast No.	Described as	Maximum Stress in Tons per Sq. In.	Elongation % in 2 in.	Reduction of Area, %.	Remarks.
Y205	EGC 899	Specimen machined from head of steel rail.	53·32	16·0	20·8	Finely granular with a trace fibrous.
Y206	„ 907	Do.	53·30	14·5	18·6	Do.
Y207	„ 913	Do.	51·88	12·5	16·2	Do.
Y208	„ 919	Do.	51·78	15·5	18·6	Do.
Y209	„ 924	Do.	52·58	16·0	18·6	Do.
Y210	„ 930	Do.	53·30	14·0	16·2	Do.
Y211	„ 940	Do.	54·40	12·5	15·9	Finely granular, with a slight trace fibrous.
Y212	„ 947	Do.	54·10	15·0	18·6	Finely granular with a trace fibrous.
Y213	„ 952	Do.	52·84	14·5	17·9	Finely granular with a slight trace fibrous.

Representing approximately 780 tons steel rails.

Test. No.	Marks on Specimen and Cast No.	Described as	Carbon by Combination	Silicon.	Sulphur.	Phosphorus.	Manganese.	Arsenic.
			%	%	%	%	%	%
Y205	EGC 899	Drillings taken from head of steel rail	0·57	0·158	0·049	0·036	0·76	0·037
Y206	„ 907	Do.	0·58	0·191	0·030	0·036	0·75	0·040
Y207	„ 913	Do.	0·58	0·196	0·039	0·038	0·74	8·042
Y208	„ 919	Do.	0·57	0·205	0·034	0·037	0·76	0·039
Y209	„ 924	Do.	0·55	0·201	0·042	0·035	0·72	0·042
Y210	„ 930	Do.	0·57	0·207	0·032	0·038	0·77	0·040
Y211	„ 940	Do.	0·59	0·222	0·035	0·037	0·76	0·042
Y212	„ 947	Do.	0·58	0·196	0·030	0·040	0·77	0·044
Y213	„ 952	Do.	0·59	0·168	0·037	0·042	0·75	0·045

On the Continent, the rails produced are mostly Bessemer rails made by the basic process. This process for rail steel is not accepted by many of the principal engineers of modern railways, and the one outward advantage rails of this material possess is a delusory cheapness. In quality they cannot be compared to the standard British rail made from accepted steels.

Trouble is sometimes experienced in railway crossings through the wearing of the tongue and wing rails, made from rails in the usual manner. The repair of these by the deposit of hard metal by the oxy-acetylene process is not a satisfactory process. The metal deposited is usually very brittle, and the heat from the flame has a tendency to distort the rail and set up strain. As an alternative, this building-up process can be carried out by electric welding, using material ranging from 140 to 300 Brinell. A material should be chosen which deposits a metal about 200 Brinell, as this will be rather more plastic than is the case with some of the harder steels.

There are two systems in use for considering the wear of rails. In the first, the weight per yard is taken as the criterion, and in the second, the depth of top wear only is considered. It is possible to determine wear by taking out the rail and weighing it. This is a clumsy procedure, which is expensive and obstructive, and at the same time it fails to show the strength of the rail at its weakest point. Another process is to swing the track sideways after the fishplates have been removed, and take a rubbing of the end of the rail. Here, again, the procedure is expensive, obstructive, and tedious, while the rubbing, when obtained, only shows the section at the point where stresses are lowest. The best method is that in which a machine is clamped on to the rail, and copies the outline on prepared surfaces. These machines consist of a horizontal sliding frame with a vertical spindle, on which two tracing points are secured. There are, of course, other procedures, such as taking a mould of the section with the aid of plastic material in a special frame, a sunprint being taken from the mould. There is also a rail-wear gauge on the pantagraph principle, and there are, finally, mechanical measuring gauges of the template and micrometer types.

In connection with this matter of rail wear, it is important to note that the weight of the rails used is a serious factor. The New York Central Railroad, for example, some years ago replaced all its 80-lb. rails by 105 lb. rails. Used in the regular road bed, the latter lasted 2·7 times longer than the lighter rails. It has been found that the 130-lb. rails last only 40% longer than 100-lb. rails, while rails of the 80-lb. class last about twice as long as the 60-lb. rails.

The Abrasive Industry in Canada

Eleven Canadian firms engaged in the natural abrasives industry in 1934 had a total capitalisation of $234,776, as against $58,556 in 1933, and employed 34 persons, earning $20,580, with a production value totalling $102,008. Production included 1,372 tons of diatomite, valued at $54,912; 987 tons of grindstones, pulpstones and scythestones ($46,478); and 31 tons of volcanic dust ($620). The Canadian pulp and paper industry used in 1934 pulpstones valued in all at $425,850, many of these being imported from abroad.

The production of artificial abrasives increased considerably in 1934, the total value reaching $7,414,853, as against $3,550,456 in 1933. The total capital investment in the industry declined slightly from $5,176,927 to $5,109,861; whilst the 861 employees earned $1,091,992. Fourteen plants were in operation, of which 13 were in Ontario and one was in Quebec. The tonnage of crude silicon carbide and fused alumina totalled 60,994 tons, as compared with 28,854 tons in 1933 and 75,449 tons during the record year, 1929. Artificial abrasives were made in six factories, located near the power centres of Niagara Falls, Ontario, and Shawinigan Falls, Quebec, whilst nine plants turned out abrasive products such as wheels, paper, cloth, pulpstones, sharpening stones and files.

Town Gas in the Ferrous and Non-Ferrous Metals Industries—PART III

Specially Contributed

The accounts of various metal heating processes carried out in gas-fired furnaces, described in the last two issues, indicate the substantial progress made in the industrial applications of town gas. This article describes its application for annealing nickel silver, sterling silver and copper in which it is shown that other factors besides initial cost of the fuel have an important bearing on the ultimate cost of a manufacturing process.

IN the manufacture of articles of nickel silver, the stamping, rolling, and cold-working of the metal necessitates several annealing processes to render the metal sufficiently ductile for further shaping. In the annealing process as commonly carried out, the metal is scaled both in the furnace and during the cooling process when the articles are allowed to cool in air. This scale has to be removed by scrubbing and pickling before further rolling or stamping can be done, since the scale may be forced into the metal surface or in the engraving of the dies.

For high-quality work, scrubbing and pickling has to be done between cold workings—*i.e.*, after each annealing process. These expensive cleaning treatments can be obviated by several processes already on the market, but the processes themselves are often equally expensive. Quite recently, a furnace has been developed by the Sheffield Gas Co., which eliminates all scrubbing and pickling of nickel silver articles during manufacture. The process already described for the hardening of high-speed steel lends itself admirably to the clean annealing of nickel silver.

The furnace incorporating the atmosphere-controlled process is of the semi-continuous type, in that a load of articles is pushed into the heating chamber, and after reaching the necessary temperature, is pushed through the furnace into a cooling chamber, and falls down a chute into the quenching tank. The quenching medium can be either water or oil, water giving a quite satisfactory result. The heating chamber is a complete muffle, and is purged with a mixture of products of combustion of gas from which the water vapour has been removed by cooling and added unburned gas. The ratio of unburned gas to cooled products of combustion is higher than is required for steel high-temperature treatment.

The process is not claimed to be perfectly bright annealing, but is so near to it that there is no necessity for scrubbing or pickling before proceeding to the next rolling or pressing process.

In the first case, where a furnace of this type was installed, the money saved due to elimination of labour to remove scale amounted to four times the cost of gas used in the furnace.

This is an excellent example of the features of a fuel other than initial cost per therm mentioned at the beginning of this article, having an important bearing on the ultimate cost of a manufacturing process.

The Bright Annealing of Sterling Silver

Pure silver is not oxidised by air or by products of complete combustion containing excess air. Sterling silver however, contains $7\frac{1}{2}\%$ of copper, and consequently is very readily oxidised, and becomes black under oxidising conditions and when heated even to quite a low temperature.

The problem of the perfectly bright annealing of sterling silver and other non-ferrous metals has been given exhaustive attention, and many intricate processes are already available. In practically every case, a complete muffle furnace has to be used, and the muffle purged with a specially prepared non-oxidising gas or mixture of gases.

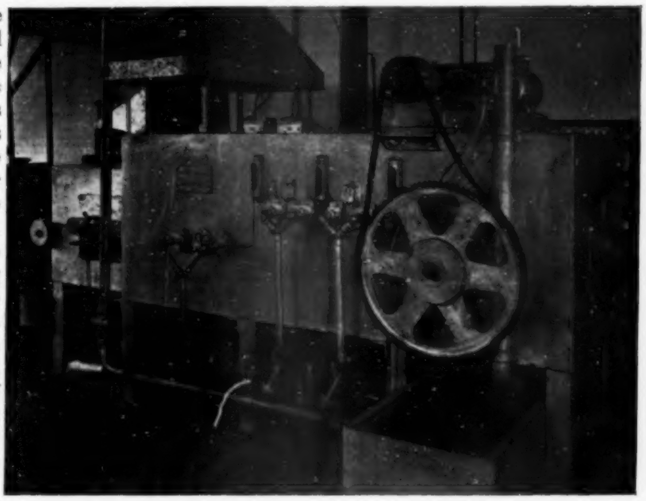


Fig. 9.—Continuous furnace, gas-fired, used for the perfectly bright annealing of sterling silver articles. The atmosphere used for maintaining the bright "finish" on the articles is obtained simply by accurate control of the combustion of the town gas used to heat the furnace. There is no muffle, and no additional source of special purging gas. The silver treated in this furnace requires no pickling whatever, and is perfectly free from "fire-mark."

Cracked ammonia, combusted ammonia, subsequently dried to give nearly pure nitrogen, hydrogen from cylinders, partially combusted butane, etc., are some of the commoner methods which have been employed. The actual results are no doubt perfectly satisfactory by any of these methods, but the Sheffield Gas Company has recently developed a process which gives perfect bright annealing of sterling silver and is much simpler and more economical than are any of the methods already mentioned.

Before describing the furnace, it may be advisable to consider briefly the chemistry of the action of gases on the metals present in sterling silver. The copper is very readily attacked to form copper oxides by oxygen, even at temperatures far below the annealing range of sterling silver. Also, both copper and silver are attacked by sulphides, such as hydrogen sulphide, even when cold, to form black metallic sulphides. Water vapour and carbon dioxide are to all intents and purposes without action on both silver and copper, or an alloy of the two metals, in the time and at the temperature required for annealing.

It would seem, then, that the products of complete and perfect combustion of town gas, containing no excess air and no unburned gas, would be a satisfactory mixture of gases in which to heat sterling silver for annealing without forming any metallic oxides or sulphides. The only gases present would be water vapour, carbon dioxide, nitrogen, and oxides of sulphur. Oxides of sulphur do not form sulphur compounds on copper or silver.

The important feature of this simple chemical reasoning is that if town gas could be burned to give complete and perfect combustion, there would be no necessity to use a muffle, and no necessity to make use of a separate supply of control purging gases.

Burner equipment to give this accurate control of combustion of town gas is available to-day, but as the temperature required for annealing of sterling silver, 750°–800° C., is low, it has been customary to use natural draught types of burners, which are quite capable of giving this temperature. These burners, however, do not, and cannot, give complete and perfect combustion—there is always either excess air, or excess gas, or even both in certain instances, and consequently, sterling silver annealed in open-type furnaces heated by natural draught burners, has always required pickling to remove surface compounds, either oxides or sulphides.

A furnace was therefore designed, heated by burner equipment of "the low-pressure air-inducing gas" type, capable of giving complete and perfect combustion. There is no muffle, and the products of combustion are therefore in direct contact with the articles as they travel through the furnace on a continuous woven metal belt. The articles fall from the belt at the outlet of the furnace into a water quench, through a water-sealed chute, so that at no time in the process do they come in contact with air.

The degree of completeness of combustion is first determined by analysis of the products of combustion, the gas and air pressures set suitably, and the burner control mechanism locked so as to maintain constant quality of combustion. With such a furnace, and with products of combustion set to the limits indicated, sterling silver can be perfectly bright annealed.

The practical and economic advantages of this process using town gas are obvious, and it is simply the very accurate control of the combustion of town gas which allows this high degree of atmosphere control to be attained.

Special purging gases are unnecessary under these conditions, all the control of the process being supplied with the heating medium itself—town gas.

The Research Department of the Sheffield Gas Co., has not confined its attention to the bright annealing of sterling silver.

It will be appreciated from the foregoing brief references to the action of various gases on the constituents of sterling silver—*i.e.*, the copper and silver, that it is the control of the reactions of gases on the copper which primarily constitutes the basis of the bright annealing process.

It has been shown in fact, in the Company's Research Department, that pure copper can be equally successfully bright annealed in the products of complete and perfect combustion of town gas, even when the town gas used is of normal composition and contains the permissible amount of sulphur.

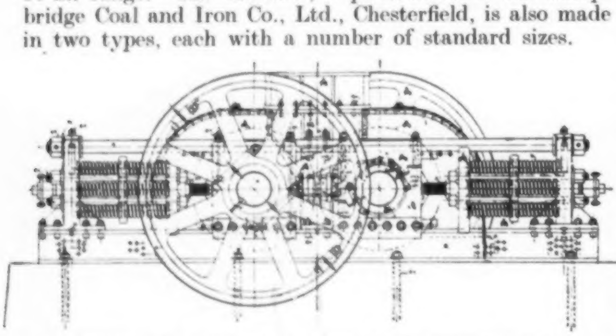
The bright annealing of copper by this process is of great importance, as here again there is no necessity to use a muffle, and there is no external source of costly purging gases required. The cost of bright annealing either sterling silver or pure copper by the process described here is confined simply to the cost of heating the metal.

Conclusion

In conclusion, it is asserted that the sphere of useful industrial application of town gas is rapidly increasing in the steel and non-ferrous industries. Its value as a fuel *per se* is already acknowledged, but as a processing agent by atmosphere control its value is being even further proved. The applications of atmosphere control, either by perfect or regulated combustion or by special systems of preparing gaseous control mixtures from town gas and its products of combustion, are as yet comparatively limited, but as research and application continue, there is no doubt that metal heating by gas will become even more precise than it has been in the past, and the old troubles of scaling, decarburisation, oxidising, and tarnishing, with the consequent grinding, scrubbing, and pickling, will be eliminated.

Heavy Duty Slugger Crushers

FOR the crushing of limestone and blast-furnace slag, considerable interest attaches to the "Kennedy" special heavy-duty double-slugger roll crusher, which has an enormous capacity, taking very large pieces of material and delivering in any desired size, within 2-in.–10-in. range. The machine, a production of the Sheepbridge Coal and Iron Co., Ltd., Chesterfield, is also made in two types, each with a number of standard sizes.



Elevation of a "Kennedy" heavy duty slugger roll crusher.

Essentially, however, the design and construction is the same for both types, consisting of two heavy rolls of special steel provided with a series of projections or sluggers, which are staggered in relation to those of the opposite roll, operating in a horizontal heavy steel H-Beam framework having suitable tension bars. The rolls are enclosed by a shell or outer casing, and are each provided with a series of heavy horizontal springs so as to allow of a certain degree of horizontal movement in the event of pieces of iron or other uncrushable material passing through. Also the drive is by means of two separate open-hearth steel flywheel belt pulleys, one on each roll independently.

In the "Type A" machine, 13 standard sizes are supplied weighing empty 30¾–96 tons, and having flywheel pulleys from 84-in. diameter and 12-in. face to 108-in. diameter and 20-in. face, running at 60–100 r.p.m. and taking 40–175 h.p. For example the largest size weighs 96 tons and has a flywheel driving pulley 108-in. diameter and 20-in. face, running at 60 r.p.m. and requiring 175 h.p. The No. 4 machine with a 96-in. diameter flywheel pulley 16-in. face taking 75 h.p., deals with up to 450 tons of limestone per hour, crushed down to 10-in. pieces, while the capacity with blast-furnace slag crushed down to below 4-in. sizes is as high as 270 tons per hour.

The "Type B" machines, in three sizes, are intended, more particularly for crushing to smaller sizes, taking say, limestone from primary machines dealing with the large pieces. Thus the No. 3 "Type B" size weighs about 24 tons empty, having a flywheel driving pulley 84 in. diameter with a 14-in. face, running at 90 r.p.m., and requiring 50 h.p. The approximate capacity is 180 tons per hour crushed down to 3-in. size or smaller, the exact figure, of course, depending upon the conditions such as the degree of dryness of the material used.

There are also available a wide range of other "Kennedy" roll crushers of the smooth and corrugated types, as well as heavy duty single slugger rolls and ordinary duty double-slugger rolls for coal.

Locked Coil Winding Ropes

By RICHARD SAXTON

The advantages which have led to the extensive use of wire rope are the results of either or both of its two important properties—its strength and flexibility. In this article, problems are discussed which arise in the fabrication of locked-coil mining ropes.

EFFICIENT fabrication of locked-coil mining ropes, due to the particular method of construction and sectional formation of wire units, presents problems not usually encountered in cylindrical wire and strand type construction, because, unlike the latter, variation in tensile strength of the component wires cannot be met by inclusion of larger or smaller units, any departure from the essential size resulting in irregular formation and ill-fitting locking sections.

Originally introduced in 1884, advantages claimed for locking construction was the use of external wires of such shape that fractured units were held in position, and the concentration of greater metal mass in equal area gave higher breaking strength than was possible with rope of the strand type. In practice, this construction has been developed to incorporate other improvements, the chief being, in winding ropes, resistance to spin; thus reducing wear on guides and curtailing the risk of collision in the shaft due to small cage clearance.

Size for size, these ropes have a 44% greater strength than round strand, and in equal tensile 16·5% less diameter. Maximum elongation is approximately 0·3% (about one-twentieth of round strand), and adjustments due to this cause are practically negligible, whilst cross-cutting of wires due to alternating direction of lay of each concentric cover has been practically eliminated.

Raw material in the form of wire rod is employed chiefly in the cylindrical formation, this shape, apart from being the more economic proposition from cost aspect, lending itself, in the majority of sections, more amenable to reduction than when hot rolled to shape or section desired. This is due to the difficulty of guiding the rolled section into a position to correctly enter the draw die and to the tendency of material in rod form to turn over during coiling at the end of the hot rolling operation.

Heat-treatment

The first process in wire fabrication or drawing is heat-treatment to eliminate stresses induced by previous work; the metal being of too hard a nature to respond efficiently to circumferential pressure imposed. For material to give a breaking strain of 105/115 tons per sq. in. in the finished locking unit, two normalising treatments are necessary, followed, at a later stage, by a further treatment known as patenting or tubing; a continuous annealing process imparting properties essential for tenacity and ductility in the finished wire. The bulk of material employed in locked coil construction is acid steel quality, with carbon content varying from 0·60 to 0·80%.

Reduction of Rod to Wire

Reduction to wire form is accomplished by passing material through a series of suitable reducing dies, plastic deformation being accomplished by circumferential pressure of die induced by the pull, and the amount of deformation effected per pass is dependent on the taper of the die and the resistance of the metal to pressure imposed, the resistance to deformation increasing with increase of carbon content.

The bearing of the die is that part with which metal makes contact and the taper is the difference in diameter of ingress and egress of the bearing. Both the angle of taper and the pressure induced must be so graded that tensile stress of reduced material is greater than pressure induced, any deviation resulting in fracture of reduced section. The action of pressure on structural formation is as follows: There is first slip on the crystal cleavage planes, known as the internal, and second, slip between crystals, termed external. Slip must at all times be uniform, the alternative being rupture of grain structure and fracture.

Fractures of wires in ropes during service are often claimed to be due to inclusion of segregated material Such inclusion is very unlikely, because the high stress to which material is subjected during drawing operation quickly reveals segregation or other defects by fracturing at the defective part immediately pressure is applied. It is admitted that many grain formations at the point of fracture do indicate segregation, but this condition is due to pressure on the exposed structure after fracture has taken place.

In cylindrical wire reduction convergence of the pressure on the centre structure elongates into finer fibres at this point, imparting a brittle nature which, under certain conditions, leads to structural disintegration when subjected to bend stress during rope service, and it is this form of defect which leads to the impression that metal is segregated.

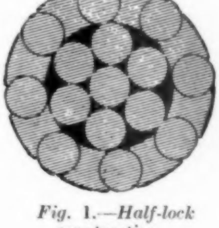


Fig. 1.—Half-lock construction.

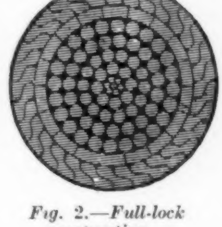


Fig. 2.—Full-lock construction.

In all cold-working methods of pressure reduction grain structure is elongated into fibres, elongation continuing with each successive reduction until a condition is reached known as "limit of elasticity." Rope wire reduced to this extreme is unsuitable, and general practice is to employ a composition furnishing in the finished wire the essential tensile and ductility without imparting stresses which detrimentally affect the rope in service.

Locking Wire Reduction

In first stages of locking wire reduction, which includes part-shaping of section from cylindrical form, the pressure applied, due to irregularity of section, is variable, and the result is a grain structure of variable formation, necessitating more frequent heat-treatment than is necessary in cylindrical wire reduction. Combination of heat-treatment and reduction is graded to furnish a shape responding to equal pressure from all sides, and this is accomplished prior to the final annealing or patenting operation.

Figs. 1 and 2 illustrate cross-sections of half-lock and full-lock constructions respectively: that shown in Fig. 1 being employed chiefly as colliery guides or aerial standing ropes. As will be noted, the sectional wires in this construction are much thicker than those shown in Fig. 2, and permit of greater wear before coming out of lock.

The construction shown in Fig. 2 is employed principally as winding ropes, and whilst many variations from the inner section as illustrated are fabricated, outer sections

are as shown, the difference being one of size only, and not in the shape of the locking section. The method of construction differs from that of strand formation in that the wires are built in layers round single-core wire, and finished with one or more layers of the locking formation. In addition to retaining fractured wires in position as previously described, the outer sectional layers prevent disturbance of inner wires by locking the circumference: they furnish a smooth exterior, and prevent exudation of lubricant incorporated during the fabrication of the inner construction.

A newer construction is illustrated in Fig. 3. This is built chiefly for guide and aerial rope work. As illustrated, the rope is of tubular, single-layer construction, but it is also fabricated in double or three-layer formation. From the enlarged section it will be noted that this construction embodies a design of locking unit totally different from that previously illustrated.

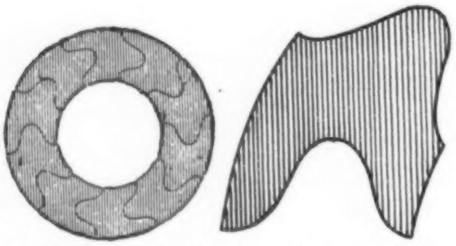


Fig. 3.—Tubular construction for guide work. The enlarged section shows the new type of locking unit.

In single-layer formation these ropes are 16% lighter than a 7-rod guide of equal diameter, and present a wearing surface equalling that of a locked coil with approximately 25% less weight. Ropes fabricated in this particular design, though tubular, offer resistance to crushing equal to that of the locked coil construction. In aerial rope formation of two, three, or more layers this construction furnishes greater resilience than spiral or ordinary locking construction, this minimising frictional wear, whilst the lighter weight permits the installation of larger diameter ropes than solid types, making possible increased arc of contact with carrier-wheels.

Factors Affecting the Service of Locking Ropes

The chief defects to which locking ropes are subjected during service are as follows: Winding, vibratory and bending: guide and aerial, corrosion and fatigue. Additional is the decrease of sectional area of wires by external and internal wear, but this is less severe than in strand construction, greater area presented to frictional wear and smoother traverse of pulley or drum easing stresses leading to this defect.

Vibratory stresses cannot be entirely eliminated, but are minimised by the provision of suitable shock-absorbers, and whilst not themselves detrimental, lead, through constant repetition to a brittle condition of metal at points where checked—namely, near load. From mathematical and experimental investigation of this problem it has been found that the condition as stated is induced by vibrations set up in an axial direction; the effects being intensified at the point nearest the load, reducing resistance and leading to a condition of "fatigue" at this point.

Though often inferred to be due to crystallisation, fatigue condition is not so, as the formation is already crystalline, but is induced by repetition of stress causing a condition of localised hardening which ultimately leads to fracture. The fatigue limit is the highest load which a metal will withstand repetitively, and the value is dependent on the application of stress. This may be alternate tension and compression of equal severity, or may be entirely pulsatory (repeated loading and unloading in tension or compression).

Bending stresses in winding ropes equal the vibratory in detrimental effect, combination of the two, where excessive, quickly leading to the fracture of units at the point where localised. Many failures of ropes by bending stress during the early period of service are definitely the result of employment of pulleys that are too small; this is proved by research and test. According to a statement credited to the late Dr. Daniel Adamson, the addition of two rope circumferences to diameter of pulley doubles rope life. Thus, a 2-in. circumference rope working under equal tension would give twice the service over a 24 in. as over 20-in. pulley. Though this cannot be accurate in each or every case, it is approximately correct, and serves to emphasise possibilities of longer service life by using pulleys of the largest diameter consistent with economic running. Maximum durability is only attained by constructions embodying outer wires as large as possible consistent with size of pulley or drum on which the rope is to work, and with the speed of rope travel.

Deterioration in locking guides is caused chiefly by corrosion and fatigue, external wear uniformly distributed over length of rope by the smooth surface being practically negligible. This can, however, occur at decking levels where the extra movement of the cage may impart extra wear at this point. External corrosion is easily prevented by efficient lubrication, but danger points are at the attachments to head-gear and weights. As clamps or capping in the head-gear usually rests on a box girder, inspection of the rope directly underneath presents difficulties. Damage to the surface wires is also possible at this point from the rope striking girders during oscillations.

Metal fatigue in guide ropes is resultant generally from the repetition of stress generated when steadying cage, and takes the form of longitudinal oscillations damaging to the top capping or clamp being reflected back during the period the rope is stressed by the dead load. Though many forms of apparatus are in use to minimise the effect of these stresses, the safest practice to avoid fatigue failure is to re-cap at intervals.

Newer construction of solid locked coil winding ropes include one or more layers of sectional wires interlocking under a covering of full locking wires, the inclusion of this formation distributing stresses to interior wires by smoother surfaces which eliminates the cross-cutting action between layers. This construction makes possible an increase in tensile strength of 18%, with approximately 5% less weight as compared with equal diameter outer-locking fabrication.

Controlling Air Supply to the Cupola

The new cupola recently installed in the Austin foundry, at Longbridge, Birmingham, is an example of the scientific accuracy with which the production of castings in the modern foundry is now controlled. This cupola is of the balanced-blast type which is claimed to give hotter and better quality iron, less loss by oxidation, and more complete fuel combustion with resulting economy of coke.

To ensure accuracy of control this cupola is equipped with B.T.H. automatic air-weighing instruments, which deliver the amount of air calculated to give complete combustion of the fuel, and the feed of raw material and fuel is also automatically maintained by a new type of charging plant. This cupola, which was built by the Constructional Engineering Company, to designs developed by the British Cast Iron Research Association, is over 6 ft. in diameter by 55 ft. in height, and has a maximum delivery of 12 tons of grey iron per hour.

At the Austin foundry it feeds two mechanised casting tracks, which, besides much other work, are making 350 cylinder block and cylinder head castings daily; further, it serves a large floor moulding section. A second cupola of the same size and type is at present in process of being installed.

We have received a copy of Data Sheet No. 32 from High Duty Alloys, Ltd., Slough, Bucks., which gives details of the methods used in the preparation of specimens for the microscopic examination of the "Hiduminium" Alloys. Those who desire a copy should apply to High Duty Alloys, Ltd.

Progress in the Production of Cast Bronzes

By FRANCIS W. ROWE, B.Sc.

In this article the author confines his attention to the melting of bronzes, and regrets that furnace equipments in the past have been selected on the grounds of easily assessable economical considerations alone, neglecting greater ultimate considerations.

WHILE it is impossible to say that any revolutionary change has taken or is taking place in the production of bronzes, steady research work and the ever-increasing demand for alloys of uniform and high physical properties are producing a marked improvement in products.

One phase in bronze-making to which much-needed and long-delayed attention is now being given is that of melting practice. The interested reception which was given to Dr. Brownsdon's paper at the last meeting of the Institute of Metals is indicative of the realisation of the importance of this long-neglected subject. While this paper naturally hesitated to be dogmatic and merely focussed attention, and the subsequent discussion revealed much difference of opinion, it is only by comparison of thought that eventual agreement and progress will be made. The importance of atmosphere and gas-absorption was clearly appreciated by all, which would hardly have been the case ten years ago. Where bronzes are concerned, particularly high tin cast bronzes and nickel-bearing bronzes, it is hard to exaggerate the importance of atmosphere in melting conditions, and probably no single feature is productive of so much trouble and so many bad or sub-standard castings in such alloys.

Unfortunately several diversely opposite theories as to the exact cause of such troubles are extant, and for some time it will be necessary for even the experienced observer to keep an open mind on the subject.

Much of the diversity of opinion that exists is due to the problem being really divided into two parts, both of which are inevitably linked together. Not only are we concerned with the atmosphere present in the furnace while the metal is being melted, but also the solid and gaseous impurities present in the metal before melting. Thus, we may have the situation that one investigator may find, say, that hydrogen present in a reducing atmosphere during melting has no deleterious effect, whilst another working with different (but not necessarily inferior) material may find that such has a very big influence on the soundness of the resultant castings.

All evidence logically obtained must, therefore, be given due consideration and theories sought for which will suit all these data.

It is now generally accepted that for most of the commonly used brasses and bronzes a slightly oxidising atmosphere gives in all normal melting conditions less trouble than one which is reducing. This is possibly due, not to any harmful effects of a truly reducing atmosphere *per se*, but to the danger of the effects of a reducing atmosphere on oxides present in the metal or the formation of other reduction compounds, themselves highly deleterious from impurities in the fuel. Sulphur compounds in the fuel have been shown to be comparatively innocuous in an oxidising atmosphere, but may easily be the source of profound unsoundness if the atmosphere is reducing. Similar remarks apply with some modification to water in the fuel (such as may frequently occur with coke), and many of the serious troubles in a bronze foundry may quite likely be attributed to dissociated water vapour, and possibly its subsequent reaction with oxides in metals. Melting in an oxidising atmosphere does, of course, sound heretical to a scientifically trained mind, but until our knowledge is clearer on this important subject it would appear to be the safer method.

It is certain, however, that the spread of electric melting and the bronze foundry industry will give more light on this subject, and with the closer control of melting will eliminate many of the variables which have obscured the issues so far.

The question of melting equipment and types of fuel have been, and are likely to be, much to the fore in bronze founding practice. Each type of melting furnace has its protagonists as has each type of fuel, and the average user is somewhat bewildered on his first attempts to sort out these claims and reconcile the various figures put before him. A great deal, of course, depends on the local conditions as regards the relative price of fuels in the areas concerned, and to a much lesser extent on the conditions in the foundry concerned. Up to ten or fifteen years ago probably 90% of the metal used in bronze foundries was melted in some form or other of crucible furnace, but since that time the "open-flame" furnace of one type or other has made considerable inroads into the field once almost exclusively held by the crucible furnace. Similarly, the fuel almost universally used fifteen years ago was coke, but latterly oil and gas-firing have made considerable progress, and electrical melting is beginning to get a foothold and may attain in this country the same importance as in the States (where a large proportion of the bronze foundry tonnage is melted in electric furnaces) or as in the brass ingot industry in this country.

The prospective purchases of bronze melting equipment is thus faced to-day with a much more complicated problem than formerly. It is impossible without detailed knowledge of the conditions to give firm recommendations, but the following notes may form some guide as to modern trends in this direction.

The crucible furnace labours under two very heavy economic handicaps. The first is that, despite the tremendous improvements that the crucible maker has made in the last few years, the cost of crucibles per ton of metal melted is an important factor, and is usually very much higher than the cost of repairs to non-crucible type furnaces. Figures for this item vary enormously, and are subject to considerable alteration, dependent on the class of metal being melted (not only composition but size and type of material charged), but a good general comparison would be that the cost of crucibles (and any lining repairs to the crucible furnaces themselves) is two to three and a half times as much as repairs to a non-crucible furnace. The other serious factor which militates against the crucible furnace is the speed of melting. Even in favourable conditions the speed of melting in a crucible furnace is only half that of a similar sized non-crucible furnace given similar conditions in other respects. Speed of melting in foundry work is a valuable factor that (unlike machine-shop operations) is difficult of assessment, and on that account is perhaps apt to be neglected in calculations. But equipment of any kind that is slow in operation, even if the capital cost is low, does eventually find its proper level, and is perforce bound to give way in the main to

faster operating plant. The chief planks of the crucible furnace are quality of product and lower metal losses than the direct flame furnace, but the successful work that the open-flame furnace has accomplished would appear to indicate that the advantages of crucible furnaces on this score have perhaps been somewhat exaggerated. Speed of melting itself is a desirable feature on the score of quality and the length of time during which the metal is exposed to the influence of the products of combustion probably nullify the advantage of having the metal protected from the direct action of the flame. In this connection it should be remembered that crucibles are highly permeable to gases at normal bronze melting temperatures.

The open-flame furnace, whether coke- gas- or oil-fired, has much to warrant attention, as will have been gathered from the previous remarks. The disadvantages of this type of furnace are the difficulties of close atmosphere control and the dangers of gassed metal, where the importance of atmosphere control is not, or only imperfectly, appreciated. Where the alloys being dealt with contain a larger percentage of volatile constituents (zinc content of 10% upwards) the zinc losses will probably prove unduly high unless very special care is taken with the design and operation of the furnace, and the alterations thus necessitated may probably seriously lessen the big advantage of this type of furnace in speed and efficiency of melting. Whether the firing of this type of furnace should be oil, coke, or gas, depends on local prices. It is doubtful whether gas can compete unless this can be secured at a price of 1s. per thousand for gas of 500 B.th.Vs. Oil presents many advantages in ease of handling against coke, but the increase in cost of approximately $33\frac{1}{3}$% due to the imposition of tax has robbed oil of nearly all its economic advantages, but where very favourable oil contracts can be made it is still worthy of serious consideration.

No one contemplating new foundry melting plant should fail to investigate the merits of the arc electric furnace, particularly where power can be secured at a price of 0·6d. per unit and under. The disadvantage of the arc electric furnace for bronze melting is its very high capital cost compared with any other type of furnace. This is largely accounted for by the cost of the electrical equipment (special furnace, transformer, and switchgear), and the electro-mechanical equipment for automatic control of the electrodes and any rocking motion of the body.

Most furnaces of this type are single-phase, and power supply authorities in this country are often frightened of an appreciable out-of-balance load. This objection will, in the author's opinion, largely disappear when power suppliers get used to this class of load. There are some 700 of this type of single-phase furnaces installed in the States, and chiefly on bronze melting. The advantages of this type of furnace, once the disadvantages of high capital cost and amortisation charges have been appreciated, are many.

Their speed of operation is quite as great as the fastest of the open-flame furnaces. In the foundries with which the author is associated a nominal 350 lb. furnace of this type melts a 400 lb. heat, and superheats to 1,275° C. in 25 mins., and 15 heats of this size can be secured in a normal working day.

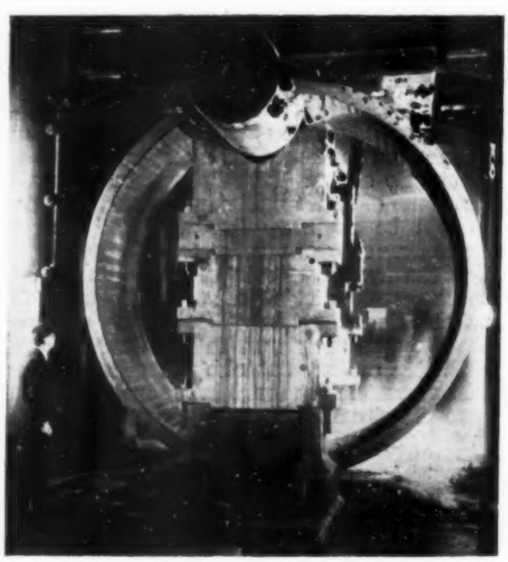
Actual fuel costs come out very low, largely due to the continual rocking action of the body, which starts immediately the charge starts to melt. Given steady production and adequate facilities for absorbing the molten metal, a furnace of this type (operating 15 heats per day) will have an overall current consumption of 320 units per ton. At 0·5d. per unit, at which most industrial consumers can secure current, this is 13s. 4d. per ton for electricity. Consumers in highly industrialised areas should have no difficulty in securing a price of 0·4d. per unit, at which price the cost for current comes down to 10s. 8d. per ton. Lining costs are low, and lower than those of the open-flame furnace, but, of course, electrode costs of 4s. per ton have to be added. Whilst it is difficult to give exact comparisons on metal loss as against the open-flame furnace, this can be taken as half that in the open-flame furnace, and lower than that of the crucible furnace.

This type of furnace also would appear to offer many advantages in control and in quality. Melting is done purely on a current consumption basis—that is, the trip on the meter is set to zero after each heat,—and, knowing the weight of metal charged and the temperature required, when a specified number of units have been consumed the metal is ready for tapping. This enables a close daily check to be made on fuel costs, and prevents overheating and any deleterious or wasteful consequences arising from this. Atmosphere conditions can be regulated to a nicety, since standardised conditions prevail, and on these grounds alone no doubt this class of furnace will find many adherents.

It is to be regretted that in the past most furnace equipments have been selected on the grounds of easily assessable economical considerations alone neglecting, through possibly unavoidable ignorance, the greater ultimate financial considerations which may accrue through uniform or higher quality of molten products.

Large Gearwheel Rim

The accompanying illustration shows what is claimed to be the largest gearwheel rim to be forged in this country. It was forged under a press to 14 ft. 3 in. diameter. The operation has been carried out at the Vickers Works of the English Steel Corporation.



A large gearwheel rim forging in a press to 14 ft. 3 in. diameter.

It will be appreciated that forgings of this size can only be produced under very large presses having a daylight between the forging tools of at least 15 ft. The new 7,000 tons electro-hydraulic forging press recently erected at the Vickers works is admirably adapted for this work, and makes possible the forging of even larger rims of this type. The portion of the ingot required for the rims, after being trepanned with a 24-in. hole, was expanded under the press to slightly over 10 ft. in diameter ; it was then reheated and forged to 14 ft. 3 in. diameter.

The expert knowledge required for this operation will be appreciated when it is realised that the machining allowance is about 1 in. on all surfaces, and that as measurements have to be taken whilst the forging is hot, allowance has to be made for the contraction which takes place as the forging cools. In this case the forging was $1\frac{3}{4}$ in. larger on the internal diameter, when finish forged, than it was after cooling.

Reviews of Current Literature

The Welding of Iron and Steel

A Symposium on the welding of iron and steel was organised by the Iron and Steel Institute in conjunction with other Societies and Technical Institutions and held on May 2 and 3, 1935. It comprised 150 papers, which were specially written for the purpose. The whole of the proceedings of this Symposium have now been published in two volumes. The papers are divided into five groups, each of which is prefaced by a summary which was presented orally at the meeting. Each group is followed by a record of the verbal and written discussions on the papers contained in it, together with the authors' replies to the comments on their papers.

The subject of the papers is limited to the welding of iron and steel, but the problems encountered are often similar to those which have to be overcome in the welding of non-ferrous materials. Discussion has not been confined to particular methods of welding, but much space is devoted to fusion welding, both by the electric arc and by the oxy-acetylene methods, since it is in these that the most interesting problems arise in technique, in metallurgy, in testing and, perhaps most important of all, in design. The information on these and kindred subjects is probably more comprehensive than any so far published. These volumes form a record of the remarkable progress made in recent years in what may be claimed to be a new method of fabrication.

Certain aspects of welding have not been considered with completeness. No attempt has been made to include a comprehensive account of different types of plant or of particular processes, whether these are covered by patents or not. The applications of resistance welding mentioned in the papers also, are not exhaustive. Treatment of these matters, where included, have been general, but it is doubtful whether more detailed analysis would have brought to light new problems or elucidated further those which are discussed. Only incidental mention has been made of the training of welders, since these volumes are concerned with materials. The detailed discussion of the revision in building and other regulations which welded structures will necessitate has also been excluded, although the effect of such regulations as are now in force in restricting the design of welded structures will be apparent.

The first group deals with present-day practice, and problems of welding, because of the wide field covered, and is divided into two sub-groups, each covering special sections of the engineering industries. The first of these sub-groups deals with various aspects of welding as applied to bridge and structural engineering, pressure vessels (including boilers, pipe lines, tubes, tanks, and vessels for use at high temperatures and pressures), railway engineering and shipbuilding. There are approximately forty papers in this sub-group in which all the methods of welding available to-day—oxy-acetylene, electric arc, carbon arc, forge, resistance, etc.—are discussed in relation to different types of structures.

The second of the sub-groups is concerned with the application of welding to the aeronautical, automobile, chain, electrical engineering industries (including marine engineering), and iron and steel castings and wrought iron. The studies in this section indicate substantial progress in welding, but it is realised that, in some of the older industries, violent breaks with tradition are seldom found.

Generally there has been too much disagreement about different processes of carrying out the same welding operation, because the characteristics and peculiarities of each were either not known or insufficiently known. With the object of examining them together with all the requisite technique, the second group deals with welding practice and technique, including welding apparatus. Various aspects are presented in twenty-five papers. It is in developing suitable technique probably that the greatest stumbling block is encountered because the building up of a satisfactory technique is the outcome of investigations carried out at the test bench with the modifications found necessary by experience when welding actual constructional work. This naturally is a slow process; even after all the years riveted structures have been built, problems still arise on which very little information is available.

Although welding has been in commercial use for many years it is only during comparatively recent years that it has been studied from a metallurgical point of view. and the third group surveys problems directly associated with this aspect of welding. This group embraces about thirty papers which give a better understanding of the problems encountered in welding and their solutions. The metallurgy of weld rod steel with reference to mild steel or low-alloyed steel is reviewed, while special steels, which present problems distinct from those connected with the welding of ordinary steels, are discussed. Much attention is given to welding rods while other papers are concerned with the study of welds.

Obviously in any new and progressive industry which includes a number of different processes the question of standardisation generally arises and, in the fourth group, the papers deal with specification, inspection, testing and safety aspects of welding. About twenty-five papers are included in this group.

These volumes include the discussions arising from the various papers and are much too comprehensive to review adequately in the space available here. They contain the entire proceedings, including all the papers, the oral and written discussions, summaries and the report of the Committee appointed by the Council of the Iron and Steel Institute. They will provide a work of reference on welding for many years to come. Published at the Offices of the Iron and Steel Institute 28, Victoria Street, London, S.W. 1. Price, £2 2s. per set.

The Uses of Tin and Some Researches

Several interesting and informative papers have been issued recently by the International Tin Research and Development Council, with a view to developing new industrial applications for tin, improving the existing products and processes, and to assisting tin consumers in overcoming technical difficulties and problems relating to tin.

Tin and Its Uses

Mr. D. J. Macnaughtan, Director of Research of the Council, has contributed a concise account of the mining of tin, the manufacture of tin alloys and their uses, and the applications of tin and its importance to industry. Modern industrialism has increased the demand for the metal from 10,000 tons to 188,000 tons a year in the last century. Improved methods of mining by dredging ensure the economic extraction of tin ore even when the concentration in the deposits is very low, and scientific control of smelting has improved the quality of the tin produced.

After discussing the fundamental characteristics of the alloys of tin with copper, examples of their applications are given which show the value of their high resistance to corrosion and excellent mechanical properties. Bearings are specially interesting examples of the use of bronze, and the conditions of service determine the best types to use. In bearings for severe conditions of service tin predominates and copper and antimony are present to the extent of a few per cent. only. Lead is the chief constituent in others with smaller proportions of tin and antimony.

Solders may contain very varying proportions of tin, according to their intended uses. Alloys containing a high proportion of tin are used in die-casting small parts for speed counters. Type metal for casting type on monotype or linotype machines must be alloys of tin with antimony and lead, in order to make the alloy flow freely, to toughen it, and to produce a fine structure with the necessary

smoothness of surface. Pewter is composed mainly of tin, and can be worked into the required articles by a variety of processes. Tin itself is useful for applications in the food industries in which resistance to corrosion and absence of toxicity are required. Collapsible tubes, tin tubes, and tin coatings on other metals, such as copper and steel, form the bulk of these applications. Sheet steel coated with tin provides the "tinplate" for the thousands of millions of cans used by the canning industry in the course of a year. Methods of coating metals with tin are hot-dipping, electrodeposition and spraying.

Tin and Civilisation

Effective transmission of many forms of energy is essential for the maintenance and progress of civilisation. Whether the energy be that of minds, or machines, or of foods, tin plays its part in its distribution. The transmission of mental energy requires the assistance of tin in type metals for printing, and in solder for electrical communications. Solders and the bearing metals containing tin make possible the distribution of mechanical and electrical power in numberless ways. Sheet steel coated with tin is increasingly important for the distribution of the earth's foodstuffs. These and many other topics are discussed in an address by Mr. D. J. Macnaughtan, delivered to the American Institute of Mining and Metallurgical Engineers, and now issued by the Council.

Improving Tinplate by Electroplating with Tin

Following on the patent of Macnaughtan for reducing porosity in the tin coating on tinplates by electrodeposition, A. W. Hothersall and W. N. Bradshaw have examined different types of plating solution and the effects of conditions of deposition, preparatory cleaning treatments, thickness of tin deposited, and of polishing after electrodeposition. The effect of bending the tinplate on the porosity of the coating, before and after plating, was investigated from the point of view of the practical value of the process, using the ferricyanide-paper and hot-water methods of testing.

Both acid and alkaline plating baths were tried, and the tinplate samples were procured from five different Welsh tinplate manufacturers. The tin coatings deposited from acid baths were not effective in reducing porosity, but those from alkaline baths, even in small thicknesses, reduced porosity considerably, and in greater thicknesses eliminated it entirely. The spangled iridescent appearance which results can be enhanced for decorative purposes by slightly etching the plates before treatment, or it can be removed by slight polishing without increasing the porosity. Porosity in bent plates could be greatly reduced by plating. The process appears likely to prove of value when applied to fabricated articles where coatings free from porosity are required. An account of this work has been published by the Council.

The Atmospheric Corrosion and Tarnishing of Tin

Resistance to tarnishing and corrosion are obvious qualities of tin which have secured for the metal and its alloys a great number of uses. New quantitative information as to these qualities is now provided by the researches of L. Kenworthy, M.Sc. Originally published by the Faraday Society last September, the results of the researches are now issued by the Council.

The tests were on samples of pure tin and two tin alloys containing, respectively, 2% of antimony and one-fifth of 1% of copper. The effects of exposure to the atmosphere were measured by (1) the gain of weight due to tarnishing indoors or when corroded out-of-doors but shielded from rain; (2) the loss in weight of samples corroded when fully exposed out of doors; (3) tensile tests on the breaking load and percentage elongation of wires fully exposed out of doors. Pure tin was slightly more resistant to indoor atmospheres than the alloys, and in the outdoor tests, with two exceptions, the tin and tin alloys were corroded less than some typical non-ferrous metals that were used for comparison.

Electrodeposition of Tin Alloy

Recent improvements in the technique of electrodeposition of tin resulting from the use of alkaline stannate baths have led to the increasing use of electrodeposited tin coatings for the protection of other metals against corrosion. For some purposes, for example, where the coatings have to withstand abrasion from cleansing materials, there would be advantages in coatings with improved resistance to wear. The possibility of modifying the baths to produce coatings of tin alloyed with other metals in order to harden them has been preliminarily investigated by R. G. Monk and H. J. T. Ellingham. The researches are described in Technical Publication Series A, No. 25, issued by the Council.

Nickel and antimony were both satisfactorily co-deposited with tin. Nickel up to 25% forms a bright deposit below a thickness of 0·0005 in., but above this the coatings become matt. The coatings are about seven times as hard as electrodeposited tin, and much harder if the conditions are arranged to produce higher proportions of nickel, but they are then rather brittle. By suitable choice of current density tin and antimony can be deposited together in almost any proportions desired from alkaline stannate-thioantimonate baths. When the alloy contained more antimony than tin, deposits as great as 0·0005 in. were not satisfactory, and although harder than tin, suffered from brittleness, which affected their wearing qualities.

The Deterioration of Insulating Oils

Thin films of metals deposited on glass by volatilisation *in vacuo* were used by P. J. Haringhuizen and D. A. Was in studying the deterioration of insulating oils in contact with tin, copper, and lead. The results of the researches are given in another paper issued by the Council.

The amount of sludge formed, and the darkening of the oil after 1,000 hours at 90° C. were quantitatively determined. The deterioration shown by these tests was less with tin than with lead, copper, and the blank experiments, from which it appears probable that tin may perhaps act as an anti-oxidant, as it was shown to do in lubricating oils by Mardles (Technical Publication Series C, No. 2). Tests made every 200 hours over a period of 1,600 hours showed that the ultimate increase in acidity was least in the oil in contact with tin. The information should be of value in indicating how the deterioration of insulating oils may be minimised.

Copies of any of the above publications may be obtained free of charge from the International Tin Research and Development Council, Manfield House, 378, Strand London, W.C. 2.

Journal of the Institute of Metals
Vol. LVII. (Proceedings), No. 2, 1935

The Newcastle-upon-Tyne autumn meeting of the Institute of Metals is commemorated in the latest volume of the Institute's "Proceedings." That gathering—the first to be held in Newcastle since 1911—was notable for the fact that it opened with an "Autumn Lecture," which led to a valuable general discussion on the subject of "Metal Melting—Its Effect on Quality." The lecture and the resulting discussion—opened by Professor R. S. Hutton, of Cambridge University—are given verbatim and should prove very helpful to all who are concerned in any way with the melting of metals. Next there is reproduced—again with a full discussion—a related paper on "Metal Losses in Melting Brass and Other Copper Alloys," by Dr. Maurice Cook.

The properties of bronzes, lead, gold, magnesium and other metals and alloys are discussed in further papers. The protection of magnesium alloys against corrosion—a matter of considerable moment to the aircraft industry—forms the subject of an important paper resulting from investigations made at the Royal Aircraft Establishment, South Farnborough.

Edited by G. Shaw Scott, M.Sc., F.C.I.S., London: The Institute of Metals, 36, Victoria Street, Westminster, S.W. 1. Price, £1 11s. 6d.

The British Industries Fair

A huge shop window which gives manufacturers the opportunity of displaying the extent of progress, so that potential buyers from all parts of the world may see the part played by British enterprise in the service of mankind. In this article is given a brief review of some of the outstanding exhibits in finished and semi-finished products in the metallurgical and engineering sections at Castle Bromwich.

ORGANISED by the Department of Overseas Trade, the British Industries Fair, which opens at Olympia, the White City, and Castle Bromwich on February 17, has become an institution. The primary object is to bring together potential buyers and manufacturers with a view to promoting sales, but even to the casual visitor the imposing displays at the various centres show the remarkable range of products resulting from British industry, while those more intimately associated with the industries represented will appreciate the high quality of the products shown. This annual exhibit of the production capabilities of British industry not only brings together potential buyers and manufacturers, but it encourages the progressive spirit in manufacture. It is recognised, for instance, that despite the work of various institutions and societies, many factories and workshops become stereotyped in their operations, and the opportunity presented by a national display of products gives manufacturers the chance to compare the relative merits of similar products which tends to improve production.

A display by the British Thomson-Houston Co., Ltd.

It will be remembered that a change was made in the Fair last year. The displays at Olympia and the White City were held in February, while the heavy industries staged their display at Castle Bromwich in May. Although this change proved quite successful, it was felt the separation of the Fair was unsuitable for visitors from overseas, and this year the original arrangement of staging the displays of the various sections at one time has been restored. There is much to be said for the complete Fair, even though its immense proportions prevent it being staged in one area, and it is probably true to say that its advantages far outweigh any arrangement which distinguishes between the sections in the time of display.

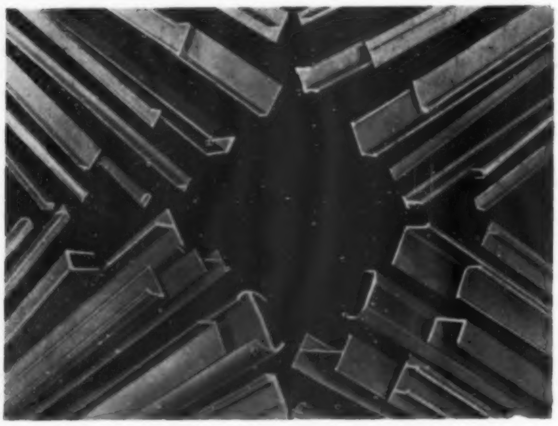
The return to the arrangement which has now been established means that the Castle Bromwich Exhibition is taking place about nine months after the last one, and to some extent this has had an effect upon some exhibitors who are not showing this year. However, despite the absence of many representative firms, the actual amount of space occupied by exhibitors exceeds that at the Exhibition held last May. It is rather difficult in such a short time to show distinct developments, but in several instances new products are being shown for the first time, while improvements in the quality of many well-known products will be noticeable.

So comprehensive is the display of the products of what are termed the heavy industries at Castle Bromwich that it would be impossible to deal with them adequately here. It is proposed, however, to refer to some of the outstanding exhibits that have a direct bearing upon ferrous and non-ferrous metal production, in semi-finished and finished form, together with the developments and products of those industries closely associated as users of these materials. Various forms of plant and equipment in which developments have been incorporated, will also be discussed, and an effort made to direct the visitor, with limited time at his disposal, to some of those exhibits which have outstanding qualities. In some instances important and interesting exhibits are omitted because adequate information is not available at the time of going to press.

Metallurgical Developments

During the last year or two a number of interesting developments, reflected in the exhibits, have been effected in steels. These are the result of research which was successfully carried on even during the period of economic depression. One of the most striking indications of progress is that made in rust-and corrosion-resisting steel, and the great improvement in castings made from these materials. Formerly, the difficulties encountered in producing stainless castings were not entirely overcome with the results that designers and manufacturers viewed them with disfavour. The production process has been perfected, and reliable stainless steel castings are now made in sizes ranging from a few pounds to several tons, and are being employed for widely differing purposes. It should be realised, however, that there are many types of stainless steel, each of which has been developed in response to the demands made by a specific set of conditions, thus, reasonable care must be exercised in determining the type for a particular application. It is in this direction that the Castle Bromwich section of the Fair can be very helpful, because technical experts are available to give useful information of this character.

For some time the welding of stainless steel has been a problem ; there has been a tendency for the local application of heat to destroy or to reduce the stainless characteristics of the steel along the weld-line. This has usually been overcome by a normalising treatment, but a quality of stainless steel is now produced which does not require heat-treatment after welding. This development facilitates the employment of stainless steels for parts and processes that could not previously make use of them. Another useful advance is in the development of stainless deep-stamping steel. Reducing the chromium and increasing the nickel in the base analysis of the normal austenitic stainless steel allows the material to be pressed or stamped out into much deeper shapes than previously. Treated



A range of extruded sections by Reynolds Tube Co., Ltd.

in this manner, the steel has high ductility and softness, and is suitable for parts likely to be severely deformed in the cold condition.

Alloy steels for constructional purposes show considerable progress—in particular the chromium-molybdenum and the nickel-chromium-molybdenum steels, which are being employed in increasing quantities. The molybdenum content of these steels, though relatively low, overcome temper brittleness, and results in increased strength and toughness. Copper, as an additional constituent of some alloy steels is being developed, and a chromium steel containing copper is now being employed for crankshaft castings—another development of considerable importance.

Changes in the tool steels have been few, but some progress has been made in the direction of finding a satisfactory alternative to the tungsten carbide-tipped tools for production work. Super high-speed steels containing cobalt have been developed as an alternative, while tungsten carbide and cobalt is being employed.

Probably the most important indications of progress are the efforts made to improve quality. Control of production and subsequent inspection in many instances are organised on such an elaborate scale that the possibilities of inferior material being supplied are almost negligible. This is not confined to the ferrous side of the metal industries, but is a noteworthy basis of the various sections of non-ferrous metal production, as will be appreciated from a careful examination of many of the exhibits at Castle Bromwich.

Alloy Steels

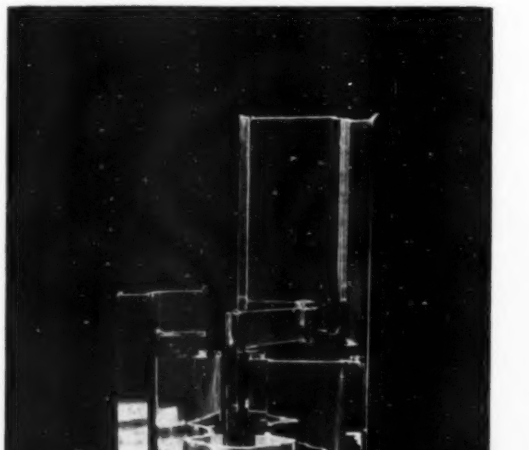
Corrosion-resisting steels have now become widely known and are being used in ever-increasing quantities, but high-quality heat-resisting steels now available are just beginning to be appreciated. For these steels considerable interest will be shown in the display of Firth-Vickers Stainless Steels, Ltd., Stands No. D 513/412. These stands will exhibit a comprehensive range of Firth-Vickers stainless and "Staybrite" steels which will illustrate the diverse and ever-increasing application of non-corrodible and heat-resisting steels for industrial, domestic and architectural purposes. The display will be sectionalised so as to give prominence to particular applications of "Staybrite" steel. Space will be specially devoted to the use of "Staybrite" steel for engineering and allied industries, whilst other sections will illustrate examples of this super rustless steel for the chemical, brewery, dairy and textile industries. In addition to demonstrating the technical and scientific facts about this new steel and its many applications, Firth-Vickers have a complete information bureau on all subjects kindred to the manufacture and use of "Staybrite" steel, and interested visitors are advised to take advantage of the facilities afforded.

The new process stainless steels manufactured by Samuel Fox and Co., Ltd., are shown on Stands D 728/829. These steels of the "Silver Fox" brand are being used in increasing quantities because the process by which they are manufactured insures that they are easy to work, take an excellent polish and are remarkably free from non-metallic inclusions. "Silver Fox" stainless steels are graded to suit all applications. Samuel Fox and Co., Ltd. also manufacture a wide range of alloy steels, and a series of those most recently produced will be on view. These will include "Durehete," a creep-resisting steel now in use in many important power stations. "Red Fox" heat-resisting steel castings, steels for dies and moulds, and "Diamet" inspected steels. "Diamet" inspected steels are made by the high-frequency electric steel-melting process, and are subjected to a very rigid system of inspection at every stage of manufacture. It is claimed that these latter steels are the most perfect steels it is possible to produce by present-day technique. A film of the whole process of the manufacture and inspection of "Diamet" inspected steels will be shown at convenient intervals.

A special exhibit of the alloy "Pireks" is shown by Darwins Ltd. This is a heat-resisting alloy developed more particularly for use in the vitreous enamelling industry for which it is held in high repute. In this exhibit will be case-hardening and annealing boxes manufactured from the same material, and those visitors who use case-hardening and annealing boxes and are not satisfied with the service from the boxes now in use may find it profitable to investigate "Pireks" boxes.

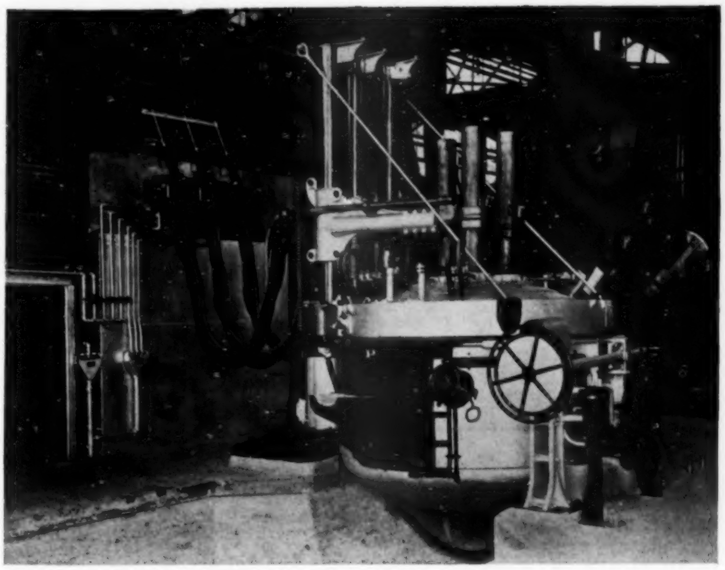
Attention is also directed to the exhibits of The Earl of Dudley's Round Oak Works Ltd., which include "Edrow" rust-resisting steel and "Edrowlite" high-tensile rust-resisting steel. A range of die steels shown by Edgar Allen and Co., Ltd. on Stand D 821/720 are worthy of examination. A number of dies actually made from these steels for production purposes will be exhibited, and those who are having trouble with their die steels will find it profitable to visit this display. The more familiar 3% and 5% nickel steels, nickel-chromium steels, chrome-molybdenum steels and the nickel-chromium-molybdenum steels will be exhibited in various forms by many manufacturers.

Nickel silver sections by McKechnie Bros., Ltd.



Case-Hardening Steels

The presence of nickel during carburising gives a more uniform case with less free carbide, a less abrupt transition between case and core, and freedom from excessive grain growth. The two principal types of nickel case-hardening steels are those containing 3% and 5% nickel, and the mechanical properties of these steels can be made to cover a wide range depending upon the quenchings in oil or water. Case-hardening steels containing 1% chromium have a high impact value and are used extensively in the automobile industry ; with care in their heat-treatment these steels give results comparable with the nickel case-hardening steels, but for specially high stressed parts the nickel-chromium oil-hardening steels are frequently employed. A range of case-hardening steels is shown by British Rolling Mills Ltd., and attention is directed to a single-quench case-hardening steel exhibited by Arthur Lee and and Sons, Ltd., Stand D 624. This is claimed to be a new departure in case-hardening steels, which has attracted considerable interest owing to its easy manipulation and the fact that all the ideal properties in the steel can be achieved by a single quench, resulting in substantial production economies.

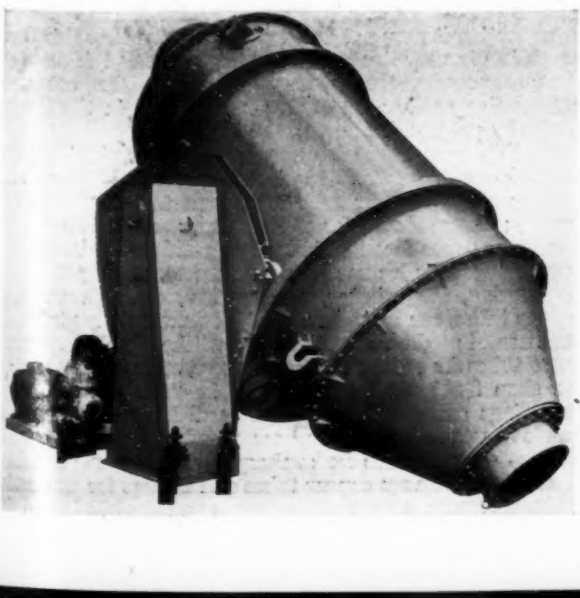


Birlec-" Lectromelt " three phase, direct arc furnace for melting cast iron, steel and certain non-ferrous alloys.

Pig Iron

During recent years scientific developments in the foundry have been very considerable, and these developments have helped the progressive foundryman to determine what constitutes the most suitable pig irons for his needs. It is generally considered to be good practice to obtain foundry irons as near to the required composition as possible, but the scientific advance has taught the foundryman the necessity for careful discrimination in the use of foundry irons for the production of various specialised goods, and as his knowledge increases, so will his desire for varying grades to meet increasing demands. What he desires most, however, is the assurance that a particular grade can be depended upon from the point of view of analysis. To meet the requirements of the discriminating foundryman Workington Iron and Steel Co., one of the companies of The United Steel Companies Ltd., supply pig irons to analysis. These will be on view at the Exhibition, which include their Workington hæmatite pig irons and " U C O " malleable irons. The display includes pigs produced in machine cast form.

Latest type five ton capacity tipping type Brackelsberg furnace by James Howden and Co., Ltd.



Stewarts and Lloyds Ltd. show the fractures of a range of pig irons they produce which will prove attractive to foundrymen, particularly those who can discriminate qualities by fracture. For those interested in the manufacture of chilled rolls and special castings, the cold blast pig iron produced and exhibited by The Earl of Dudley's Round Oak Works Ltd. will prove interesting.

Malleable Iron Castings

Several firms who specialise in " black heart " malleable castings will be represented at Castle Bromwich. Ley's Malleable Castings Co. Ltd., who are exhibiting, claim that " black heart " malleable iron is definitely superior to any other malleable iron manufactured in this country. At these works the composition of the iron is under strict control, its tensile strength is consistently maintained at 24 tons per sq. in., in contrast with the British Standard Specification of 20 tons per sq. in., its elongation is 18%, instead of 7½%, and its cold bend test 180° instead of 90°. Further, it is exceptionally free cutting, due to the presence of graphitic carbon and the absence of hard spots, permitting high machining speeds with reduced wear and tear on tools. These properties, combined with its high resistance to shock, have led to its extensive use for highly stressed parts on motor-car and commercial vehicle chassis.

In order to meet the increasing demand for their castings, Ley's Malleable Castings Co. Ltd., recently greatly extended their already large foundries—the largest of their kind in Europe—the area of the works being increased to 40 acres with a capacity of 450 tons of malleable castings per week. This has involved the building of two additional foundries with the most up-to-date plant, a new core-shop and process buildings, the equipment of which includes a battery of eight large annealing ovens of an entirely new type, and the most modern type of fettling, cleaning and setting machinery. Re-organisation of the system of progressing of orders has accompanied these extensions in order to expedite delivery of castings and give better service.

Typical castings, mostly machined in Ley's " black heart " malleable, will include motor-car hubs, differential cases, etc., also a selection of Ewart's chains for power transmission, elevators and conveyors. " black heart " malleable iron castings will also be exhibited by Thomas L. Hale (Tipton) Ltd. ; they will include castings used by the British Admiralty, War Office, G.P.O., Crown Agents for Colonies, principal home, colonial and foreign railways, leading electrical, agricultural, dairy, domestic, textile, and

Installation of a No. 10 Atritor firing a reverberatory furnace suitable for melting pig iron or scrap, by Alfred Herbert, Ltd.

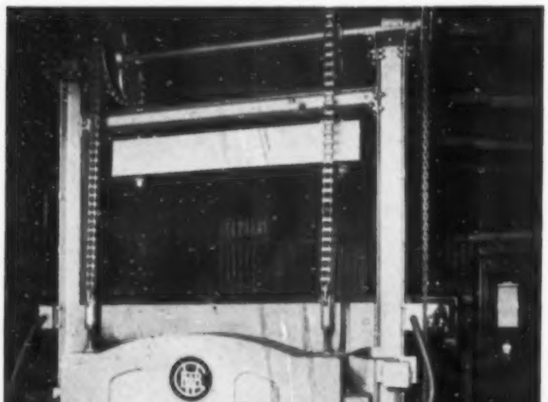
general engineers, ship builders, motor-vehicle, cycle and motor-cycle manufacturers.

Tubes and Sections

The range of tubes and sections now available in both ferrous and non-ferrous metals is remarkable, and shows the great demand for these semi-finished products in the majority of the engineering industries. Progress in the manufacture of seamless tubes has been achieved as a result of a combination of technical and practical experience. In the production of steel tubes difficulties have been overcome, as has been the case in brass, copper and non-ferrous alloys tube trade. Large-diameter steel tubes are now manufactured from solid billets of much smaller diameter than the finish tubes by a secondary expanding process. Quite a number of steel manufacturers produce billets suitable for the purpose in qualities up to 0·6 carbon. Apart from ordinary carbon steel tubes, considerable development has been effected in making stainless steel tubes.

An excellent range of steel tubes is exhibited by Accles and Pollock Ltd. It is interesting to mention that small tubes with a very minute bore are shown in this display. Tubes of these small sizes, with very thin walls, are in great demand by manufacturers of optical goods and for such

An electric furnace installed for chain annealing, by Wild Barfield Electric Furnaces, Ltd.



purposes as hypodermic needles. These tubes are costly to manufacture, and their production is recognised as a special branch of the tube trade. In addition to these fine tubes, Accles and Pollock are showing high-pressure tubes, Diesel oil-feed tubes, steel tubes made to fine limits and in light and heavy gauges, tubes with polished bores, and tubes lined or covered with copper, fibre or compressed paper. Stainless steel tubes, in various forms, plain and manipulated, will also be exhibited.

Another noteworthy exhibit of this character is that of The Chesterfield Tube Co., Ltd., which will consist of cold-drawn weldless steel steam pipes for high-pressure steam installations, weldless steel cylinders for the storage of oxygen, acetylene, hydrogen, carbon-dioxide, coal, gas, ammonia, etc., and weldless steel headers for boilers and superheaters. Large weldless steel gas storage cylinders measuring over 20 in. in diameter, and solid-drawn tubes manufactured from the latest corrosion- and heat-resisting alloy steels will also be displayed. In regard to the exhibit of steam pipes, it should be mentioned that many pipes similar to those which can be seen at the Fair were supplied by The Chesterfield Tube Co. Ltd. for the R.M.S. *Queen Mary*.

Mild steel and stainless steel tubes are also exhibited by The Britannia Tube Co. Ltd., who include brass-cased steel tubes in various finishes. Wellington Tube Works, Ltd. will have a comprehensive display of mild-steel and wrought iron tubes and fittings for gas, water, steam, etc., also special pipework of every description, such as fabricated pipework for power plants, loose flanged tubes for compressed air, point rods for railways, guard rails, sign posts, ventilating columns, tubular scaffolding, etc. Included in this exhibit are " Wellington " coated and wrapped tubes for gas and water purposes. This is a special coating composed of one or more impervious fabric coatings. The surface of the tube is covered with a specially-prepared compound which is impermeable to water or electrolytic action.

It is noteworthy that Serck Tubes, Ltd. have taken more space at this year's Exhibition in order to give a more adequate display of their wide range of non-ferrous tubes and sections, particularly many new sections which have not previously been on view. In addition to a full range of tubes in brass, copper, aluminium, gilding metal, bronze, tin and Admiralty metal, this firm is displaying alloys which have been proved in practice to reduce the corrosion difficulties encountered in circulating and cooling plants.

With regard to service copper, users are now more fully alive to the advantages of a smooth bore tube, and special attention has been paid to this, also to the purity. Serck tubes copper is guaranteed of a purity of 99·9%, which is highly suitable for bronze or copper welding ; in addition, these tubes are made in a temper suitable for manipulation without further heat-treatment, particular attention being paid to the temper required for cone joint fittings. In the brass section it may not be generally known that this firm specialises in very light gauge tubing to a wall thickness of five-thousandths, these tubes being used for car and aero engine cooling, all tubing being made in the Serck works by patented processes.

Another comprehensive range will be exhibited by Earle, Bourne and Co., Ltd., including cold-rolled brass of various alloys, copper and aluminium alloy (" Sebalin " brand) ; brass sheets for electric fires ; special brass for condenser vanes for radio industry ; solid drawn brass and copper tubes for locomotives, condensers, sugar refineries, engineering, shipbuilding, refrigerators, etc. ; brass and copper tubes, round, square, oval, flat, twisted, reeded and ornamental ; drawn sections ; polished and lacquered cased tubes for bedsteads, shop fittings, etc. ; bronze metal for shop front work ; handrails in brass and bronze ; mouldings and tubes for fenders and hearth furniture ; bends in square brass, round cased and nickel silver cased tube ; copper bends for sanitary, plumbing and heating trades ; light gauge copper tubes and fittings for domestic water services ; copper tubes for gas and electrical conduit

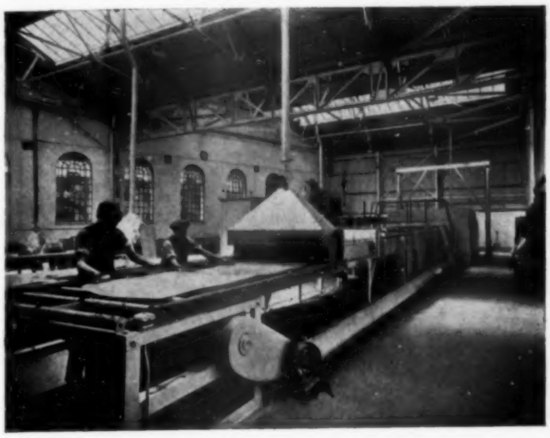
purposes : aluminium alloy angles, channels and sections ; brass and copper film, and special brass for the clock industry.

An interesting display is planned by Reynolds Tube Co., Ltd., who, in addition to their wide range of tubes and sections, for which a high reputation has been won, will show tubes and sections in "Hiduminium" alloys. The remarkable strength of these alloys in comparison with their weight is finding increasing applications for a wide range of tubes and sections, which give considerable interest to this display.

Non-Ferrous Metals

Despite progress in the ferrous industries, the demand for various forms of brass and bronze materials continues to increase, and one of the most imposing range of products of this character will be displayed by McKechnie Brothers Ltd. In this display are standard alloys for extrusion and stampings ; extruded rods and sections in brasses, bronzes, white metal and copper ; solid metal pressings and stampings ; chill cast bars ; ingots in gunmetal, phosphor bronze, type metal, terne metal, coating metal, yellow brass, manganese copper, nickel silver, aluminium alloys, die-casting alloys, and anti-friction metal. Production is under the supervision of a staff of metallurgists who make upwards of 250 analytical and physical tests per day, which ensures uniformity and soundness in the metals supplied.

I.C.I. (Metals) Ltd. have recently acquired the manufacturing rights of "Everdur," a copper-manganese-silicon alloy, which has met with great success in the United States of America, and they will be showing this for the first time at Castle Bromwich. It is non-corrosive and almost as strong as steel. The display will show the different forms in which it is sold. The main products of I.C.I. (Metals) Ltd. are sheet, strip, rods, tubes, plates and wire. Hot-rolled sheet will be shown, and cold-rolled materials such as is supplied for the general pressings and smallware trade. Rod of all kinds—hot stamping, free turning, etc.—is made for light and heavy general engineering purposes, and certain shapes are finding increasingly important applications in architecture. Tubes range from 15½ in. in diameter down to the smallest copper piping used for oil and petrol feeding. Condenser tubes of all kinds will be shown, including cupro-nickel tubes as supplied to the *Queen Mary* ; housing tubes in copper ; boiler tubes and pipes, etc. There will also be wire of all qualities and in all alloys, including copper



Large "Birlec" continuous belt conveyer furnace for bright annealing non-ferrous sheets.

wire for electrical purposes and rivet making, brass wire for rivets, pins, screws, heading, etc.

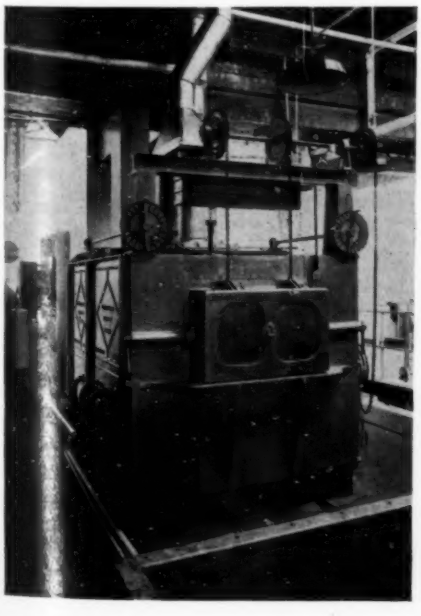
Massive copper firebox plates, as supplied to the "Silver Link," "Royal Scot" and other locomotives, will form another exhibit, and a display of Kunial copper and brass alloys in various forms will include interesting tools in Kunial brass possessing non-sparking qualities, and harder than those usually made in non-ferrous alloys. There will be a demonstration of the assembly of the patented "Broduit" copper conduit system, which embodies pressed copper fittings, showing the ease of jointing associated with this system.

The copper-nickel alloy, Monel metal, is displayed in various forms by Henry Wiggin and Co., Ltd. Part of the stand will be devoted to a model kitchen which will be used to illustrate the surprising number of applications, the remainder is occupied by various exhibits relating to a number of industries, particularly those in which resistance to corrosion, cleanliness and high mechanical properties are required. In the laundry industry, for instance, Monel metal is widely becoming recognised as the most suitable material for washing machines, and part of an interior cylinder in one of these machines will be on view on this stand. A pickling crate is another interesting example of an important application ; other exhibits include a dye-vat lining ; a steam-jacketed pan used in the food industry ; a slotted plate for a paper-pulp strainer a centrifugal basket used in many gas and coke oven plants ; and many other applications.

Electroplating

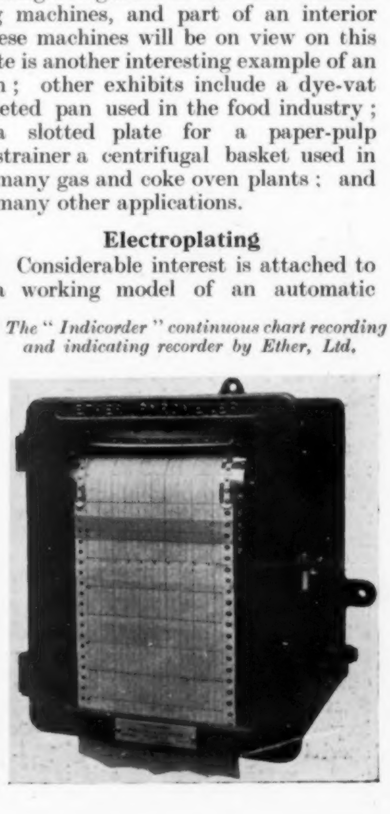
Considerable interest is attached to a working model of an automatic

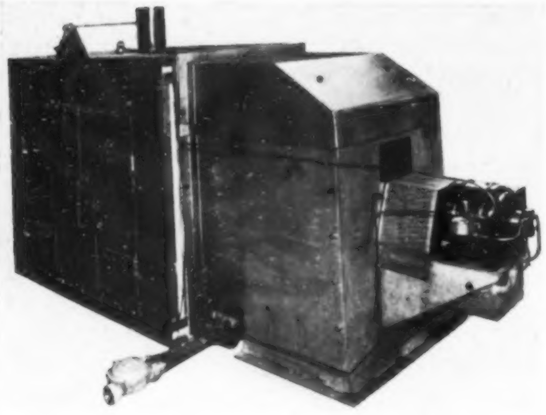
Gas fired recuperative oven furnace for general heat-treatment purposes at temperatures up to 1,000° C. by Incandescent Heat Co., Ltd.



Gas fired natural draft pot furnace for salt-bath hardening and case hardening.

The "Indicorder" continuous chart recording and indicating recorder by Ether, Ltd.





A gas-fired recirculated atmosphere tempering and stoving oven by Serck Radiators, Ltd.

plant for nickel plate, exhibited by W. Canning and Co., Ltd., the original of which is approximately 100 ft. long. An automatic nickel-plating plant of this design was recently installed in the Manor Mills of Hercules Motor and Cycle Co., and is illustrated in this review. Visitors will find the working model of particular interest; for their information we give a brief account of the process.

In the nickel-plating plant the articles are first immersed in a cleaning tank containing hot cleaning solution, working in conjunction with electric current, which very effectively cleans the work to be plated. The solution is continuously agitated by jets of compressed air emanating from the bottom of the tank. A special air blast is provided at the end of the tank issuing from a pipe fixed close to the surface of the solution, which blows scum, etc., back to the incoming end of the tank, at which point it washes over a division into a section reserved for its reception. In this way the surface of the solution is kept clear.

Ample swilling is very necessary after each particular process, and a cold-water swill follows in a lead-lined tank containing clean cold water, which is kept in a state of violent agitation by compressed air liberated from pipes at the bottom of the tank. Surplus or waste water flows over a weir at the end of the tank, while the incoming clear water feeds in at the bottom, and in addition a spray is provided the full width of the tank, at the surface, thus ensuring perfect swilling under all conditions.

The work is now passed for one half-minute through a cyanide solution. This process is to remove any oxidation of the work which may have occurred in the preceding preparatory hot cleaning tank. Another cold water swill follows in a similar swilling tank to that immediately following the cleaning tank, efficient swilling being of first importance at all stages. An acid dip is the next stage. This is a short time process, and consists of immersing the work in a weak solution in order to neutralise any possible trace of cyanide on the work, which would be detrimental to the solution. The articles are next immersed in another cold-water swill, where they are again throughly swilled and rendered chemically clean, before being transferred to the nickel-plating vat.

The actual process of electro-deposition of nickel ensures a perfect coating for the metal and uniform thickness of deposit on all shapes and sizes of articles put through the plant. The deposition is rapidly effected, and the solution is continuously filtered to ensure freedom from suspended impurities. Depolarised nickel anodes of special cross-section are employed. The timber vat is lead lined, and is fitted with all the required electrical connections designed to carry the large current necessary. In the bottom of the vat is fitted a series of perforated lead pipes, by means of which air agitation of the solution is obtained to enable a high current density to be used.

Immediately after nickel-plating, the work is required to be again thoroughly swilled in a cold swill, to free the articles from any nickel solution, and a final hot-water swill follows to bring the articles up to a reasonably high temperature before being removed from the plant.

Melting Furnaces

It is impossible to show any exhibits truly representative of the large and varied types of melting equipment with the limited space and facilities available at the British Industries Fair. Even individual exhibitors find it impossible to be fully represented, but information required is available from technical experts associated with the various exhibits.

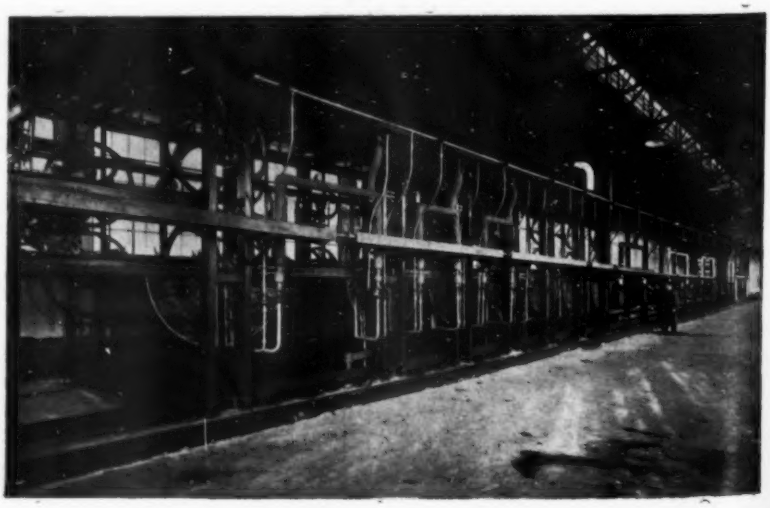
An electric melting furnace of considerable interest is exhibited by Birmingham Electric Furnaces Ltd. It is a Birlec-" Lectromelt " furnace, and since this equipment has not previously been made or exhibited in this country, a brief description will be of interest. The furnace is of the direct-arc type, arranged for three-phase operation, having three graphite electrodes projecting downwards through the roof, the bath of metal in the crucible forming the common terminal. It is adapted for cold melting steel scrap, etc., steel refining, producing high-test and alloy cast-irons, either by cold melting or duplexing, and for the melting of certain non-ferrous alloys.

The construction incorporates a number of noteworthy features, the most important of which is the patented top-lift, quick-charging arrangement fitted to certain models. This arrangement provides for the entire roof of the furnace being lifted bodily upon an hydraulic ram, and swung clear of the shell, so that a complete charge can be dumped on the hearth in one operation by means of a drop-bottom bucket on an overhead crane. In this way the time required for charging the furnace may be reduced to two or three minutes only with not only an increased output capacity per day equivalent to one full heat, but also a notable saving in both power consumption and electrode consumption.

The top charging arrangement, it should be noted, maintains the furnace roof in a horizontal plane at all times, and therefore subjects the roof refractories to no unusual stresses. The roof, therefore, is fully as robust as a fixed-roof furnace, while a good fit between the roof and the remaining part of the casing is ensured by judicious water cooling of the refractories at the points of abuttment.

The electrodes are held in exceptionally robust and

An automatic nickel-plating plant, a model of which is exhibited by W. Cannings and Co., Ltd.



rigid one-piece arms which are fitted with crossheads arranged to slide vertically on machined-steel masts fixed to the rear of the furnace. The arrangement is such that the arms can slide without any side-sway, but, at will, may be swung round, clear of the furnace, to permit easy replacement of the electrodes.

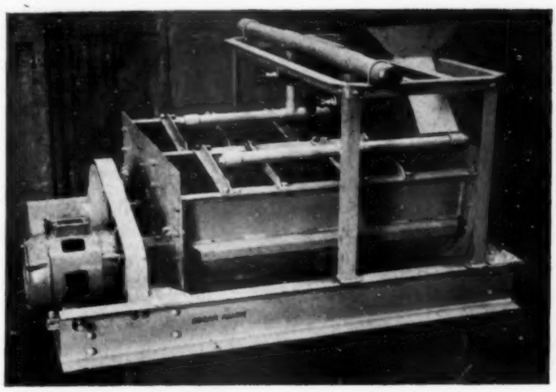
The electrode control mechanism raises the arms by means of steel cables passing over pulleys with a compensating arrangement to prevent movement when tilting the furnace. The arms are completely counterbalanced, and the cables are passed over the drums of motor-driven winches which are energised through the agency of current relays, so as to maintain the electrodes automatically in the required position for keeping power input at the desired value. The electrode-control arrangement, it should be noted, is mounted remote from the furnace, in the sub-station, where it is accessible, yet protected from dirt and damage.

The furnace body is tilted by a screw-thread enclosed in a telescopic sleeve engaging with a pivoted nut on the casing, and rolling the latter on curved segments attached to each side and bearing on rails incorporated in the foundations. All the mechanism, it should be noted, is above ground, there being no apparatus whatever in the pit below the furnace, where there is risk of damage by slag, metal and dirt generally.

The use of pulverised fuel for melting furnaces is making progress, and information regarding the application of this system is available on the stand taken by Alfred Herbert, Ltd., who exhibit an Atritor. Tin, lead, copper and brass furnaces of various types are being successfully fired by this system. The melting of alloys of copper, and the production of B.S. copper, tough pitch copper, and phosphorised copper are also being dealt with by pulverised fuel.

An interesting exhibit is that of Gibbons Brothers, Ltd., who show a rotary gas-fired enamel melting furnace for experimental batches of enamel frit. The furnace is suitable for melting a charge of 50 lb., and is similar in design and construction to the large rotary enamel melters built by this firm, which handle batches of 600 lb.-700 lb. of frit at one charge.

A model Brackelsberg rotary furnace, exhibited by James Howden and Co. (Land), Ltd., will attract considerable attention. A number of improvements have been made in furnace design and construction by this company, particularly noteworthy is the multi-jet type burner designed in collaboration with H.M. Fuel Research Station, Greenwich, which is now fitted to all pulverised oil-fired



The "Imperial" vibrating scrubber and washer by Edgar Allen and Co., Ltd.

Brackelsberg furnaces; a small swinging-type burner will be shown. This furnace has been developed for the production of high-duty grey iron, malleable iron, steel and alloy irons.

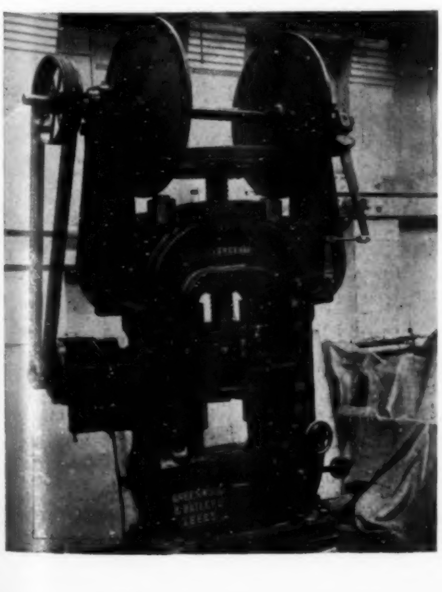
Heating and Heat-Treatment Furnaces

A wide range of electric furnaces of various types will be shown by Wild-Barfield Electric Furnaces, Ltd., these ranging from the "heavy-hairpin" box-type furnace down to the smallest muffle and including their forced-air circulation furnaces; practically all the furnaces on this stand will be in continuous operation. The large box-type furnace, suitable for carburising, annealing, normalising, etc. is fitted with their patented "Heavy-Hairpin" elements which have proved so successful; these elements have an exceptionally long life even under the severest operating conditions, thus keeping maintenance costs down to a very low figure.

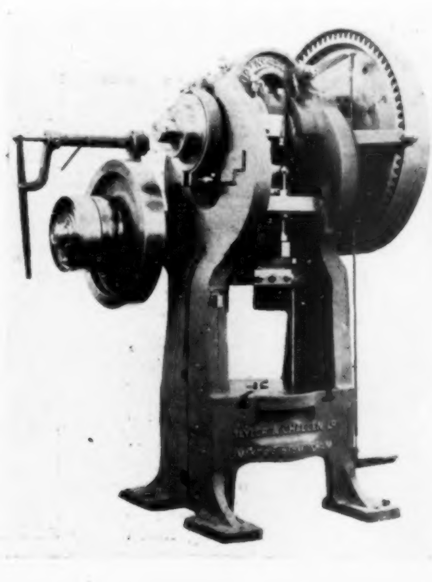
As a result of experience with this type of element in the larger furnaces, Wild-Barfield have recently incorporated a slightly modified form of them in a smaller type of furnace, the "Hairpin-Minor," which will be shown as preheater for a high-speed steel-hardening equipment. This element is also suitable for many other heat-treatments, including carburising, hardening, normalising, etc. The high-temperature furnace of the high-speed steel hardening equipment is also a new development on the older type. It incorporates the firm's patented method of compensating for the change in resistance of the recrystallised carborundum elements, a feature which greatly extends their life and thus reduces maintenance costs.

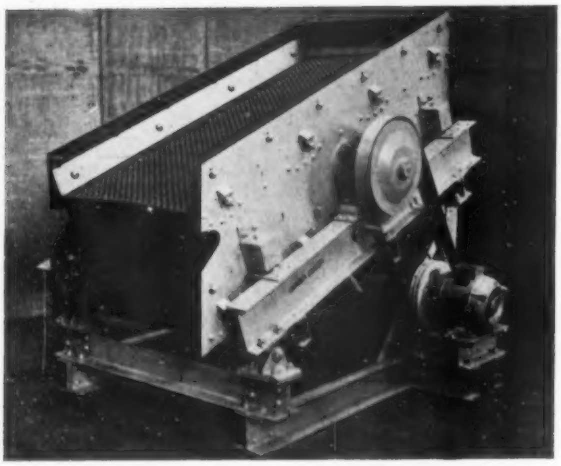
Of small muffle furnaces, there will be a very wide range, including the rectangular and oval horizontal types, vertical types, and tube muffles; these latter furnaces have proved very popular for use in laboratories, owing to their ease of control and lack of any fumes, whilst the others are used in engineering works both large and small throughthe world. There are out also two automatic hardening furnaces, one in the vertical, and the other in the horizontal form. This type of furnace is well known for the hardening of carbon, carburised and low alloy steels, because

A "Greenbat" No. 7 screw press of 125-ton capacity on view making brass stampings.



A press exhibited by Taylor and Challen, Ltd., under operating conditions.





The "Imperial" vibrating screen by Edgar Allen and Co., Ltd.

the exact point at which the charge should be removed from the furnace and quenched is given by a magnetic indicator.

Three vertical furnaces with forced-air circulation will be shown. These furnaces, equipped with the Wild-Barfield patented centrifugal fan and combined charge progress recorder and automatic temperature-controller, are widely used for a variety of low-temperature heat-treatments, such as tempering, secondary hardening of high-speed steel, and other treatments, of both ferrous and non-ferrous materials. Two of these furnaces are of the production type, and the third, their Toolroom Tempering Furnace, which has been specially designed for use in the toolroom and for production tempering of small components. This last furnace is a simplified form of the larger production models, but,however contains all the essential features which make for accurate heat-treatment, and combines a low initial cost with low running costs.

Birmingham Electric Furnaces, Ltd., have their works near to the Castle Bromwich section, and although specially constructed models of many furnaces are exhibited, the stand will form essentially an advisory bureau for the technical discussion of melting and heat-treatment problems and the practical demonstration will be staged at their own works, where furnaces are available covering a very wide range of processes, including bright annealing, scale-free hardening, bright copper brazing, etc. On the stand model furnaces will be supplemented by explanatory diagrams and photographs, while typical products from "Birlec" furnaces will be exhibited.

Another interesting exhibit is that shown by Gibbons Brothers, Ltd.; it is a continuous annealing or heat-treatment furnace fitted with a novel type of conveyer mechanism, known as the "Baldwins-Marchant" furnace conveyor gear. Originally designed for conveying steel bars for sheet and tin-plate manufacture, through a re-heating furnace. Messrs. Gibbons Brothers have now developed it for conveying steel trays carrying pressings, stampings, etc., through a heat-treatment furnace. The gear is of the intermittent pusher type, but is so arranged that each pan or bar is pushed separately for the whole length of the furnace, and the pans are not, therefore, subject to compression whilst at red heat, as is the case with the ordinary type of pusher furnace. The furnace also automatically empties itself at the end of the day's work, which is not possible with the ordinary pusher gear.

A new application of pulverised coal to the firing of small furnaces is shown by Alfred Herbert Ltd. A No. 6 Atritor, which has a capacity of 500 lb. of coal per hour, is arranged to fire four small furnaces of a type commonly used for drop forgings and of a size not hitherto considered suitable for pulverised coal firing. The plant is arranged to fire these furnaces by means of this firm's ring main distributing system, which can be used for the firing of a large number of furnaces, up to 14 or more.

The installation consists of a small coal elevator of the Redler type, which feeds the raw coal into an overhead bunker. From this bunker the coal passes into the Atritor, which dries and pulverises the coal and delivers it into a small storage bin holding a few hours' normal requirements. At the base of this bin is fitted a pulverised coal feeder driven by means of a variable speed motor, which in turn delivers the pulverised coal at a known rate into an air main running round the stand, and tappings are taken off this main to serve the individual furnaces. These tappings are controlled by means of valves, so that each furnace is under precise control at any time. Any coal dust remaining in the line is returned to the fan for re-distribution. The furnaces will be of a type which will normally burn about 40 lb. of coal per hour, and the quality of heating will be demonstrated.

The Cassel method of case-hardening differs from pack hardening in that, instead of employing a compound in the solid state as the means of introducing carbon, it uses a case-hardening agent in the molten state. On the I.C.I. stand there will be shown three furnaces working on case-hardening, including an oil-fired furnace for light cases, and a "Rapideep" furnace gas-fired—this being a comparatively recent introduction for obtaining a deep coat with rapidity. "Rapideep" is used with the ordinary case-hardening bath, but the case depths obtained, besides being deeper than those conferred by a cyanide bath, have the advantage of being glass hard for over half their depth, as compared with a third in cyanide, so that grinding allowances are greater. Where distortion is absolutely unavoidable, the "Rapideep" method is particularly suitable. A new introduction will be an electrically-heated furnace with a carboneutral bath. This will be of great value for the hardening of high-speed steels.

James Howden and Co., Ltd., are exhibiting a semi-muffle-type heat-treatment furnace. It is oil-fired, and has internal dimensions of 3 ft. × 2 ft. × 1 ft. 6 in. It incorporates this company's latest design of thermostatic control equipment, and is suitable for case-hardening, annealing, etc. The oil firing is of the well-known Howden-Burdon type.

A "Comb Circle" model of the I.C.I. degreasing plant for cleaning parts of textile machinery.

Gas Section

A noteworthy exhibit is that organised by the British Gas Federation, which illustrates the development of modern gas-fired furnaces to meet the needs of modern manufacturing technique. Although, of course, it is impracticable to show large furnaces at such an exhibition, some idea of the large scale of modern gas furnaces may be obtained from a forge furnace which is shown working and which has a working chamber 4 ft. × 4 ft. × 4 ft.

Probably the most important section of the exhibit is devoted to the heat-treatment of steel. A standard batch type of oven furnace forms the centre-piece. Having very thick insulation, efficient recuperators and automatic control, this furnace is eminently suitable for general purpose work, including hardening, normalising, annealing and case-hardening. A variety of salt baths and high-speed steel hardening furnaces is also demonstrated. The recent advances in salt bath hardening processes make the salt baths of particular interest, while the controlled atmosphere high-speed steel furnace, which is becoming so popular, particularly in the Sheffield district, never fails to draw a crowd.

Other important exhibits are non-ferrous metal-melting furnaces, one of which is of the semi-rotary reverberatory type ; a plastic moulding press which is shown at work ; an oxygen cutting machine for precision work ; a re-circulated atmosphere furnace for tempering and drying processes ; and a series of small modern muffle furnaces. Boilers and burner equipment of all kinds make up a most comprehensive display.

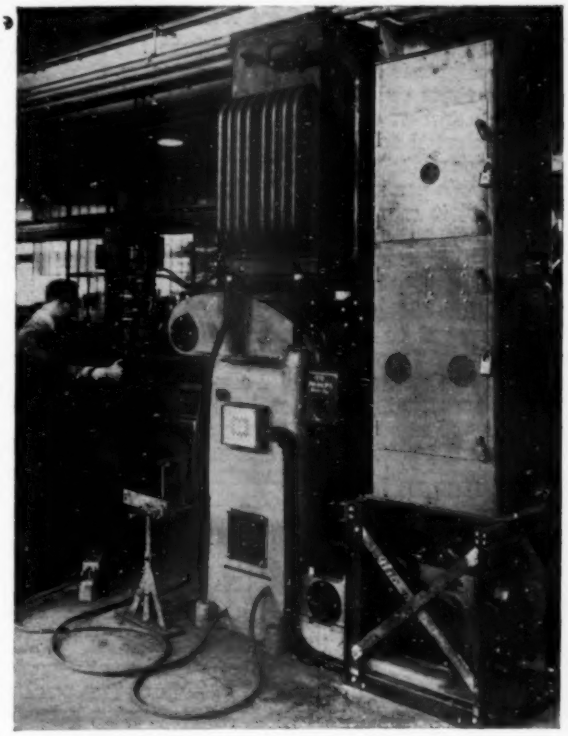
A striking thing about the whole exhibit is the amount of automatic control gear and recording gear which is fitted to the various furnaces. The added accuracy and lowered running costs associated with automatic control are rapidly being realised, and this is one of the most important reasons for the advance of town gas as an industrial heating medium.

So many firms are co-operating in this exhibit that it is only possible to mention a few here, but visitors will find the display both interesting and informative, and, if only to see the remarkable progress in the application of town gas, it should not be overlooked. Among the firms represented are Sir W. G. Armstrong Whitworth and Co., Ltd., Thos. Ashworth and Co., Ltd., Brayshaw Furnaces and Tools, Ltd., British Furnaces, Ltd., The Cassel Cyanide Co., Ltd., Davis Gas Stove Co., Ltd., Gibbons Brothers (Dudley), Ltd., The Transcendescent Heat Co., Ltd., and several firms who specialise in ancilliary equipment, such as the Cambridge Instrument Co., Ltd., Electro-flo Meters Co., Ltd., Elliott Brothers (London), Ltd., Ether Ltd., The Foster Instrument Co., Ltd., and many others.

Forging Plant

Greenwood and Battey, Ltd. will have an attractive and interesting working exhibit showing three of their popular "Greenbat" machines producing components. These include a 1½-in. hot forging machine producing high tensile steel forgings for the automobile trade ; a No. 7 screw press of 125 tons capacity making brass stampings for the engineering trade ; a small crank press trimming stampings, and engaged on general press work ; and a ⅜-in. cold heading machine producing ⅜-in. steel cheese-head bolt blanks for trimming to Whitworth standard hexagon. The exhibit includes a forging furnace and a heat-treatment furnace both by Lucas Furnaces, Ltd.

A press for hot brass pressing, shown extruding a tail-pipe from a billet of hot brass, is exhibited by Taylor and Challen, Ltd. This is a single geared crank press with 8-in. stroke, and running at 60 r.p.m. For this class of work, geared presses are found to be advantageous, although a high speed has to be used. The press is rated at 100 tons. The billet is placed inside a collar which forms the outer part of the lower die, and this is carried on a spring, so that on the descent of the slide it is pushed down by the top die, and the billet is totally enclosed between the dies before the extruding operation begins between the top and bottom inner punches. In this way no flash is formed on the pressing. Finally, the article is ejected from the top die by a positive extractor. It is found that by using a crank press the metal is actually improved by the pressing operation.



B.T.H. Thyratron controlled high speed resistance welder.

An internal notching press for use on stator rings, whose centres have been previously separated, suitable for sizes from 23½ in. down to 4 in. on the punching circle. The dividing is done by a friction band, the feed mechanism being held during the punching operation against a lock-bolt adjustable for angle. The division wheel rotates round a carrier ring bolted and checked to the table of the press and adjustable to suit the diameter of the slots ; rings of different diameters may be used on the same press-frame to accommodate different outer diameters of plates. The press will run up to a maximum speed of 400 r.p.m., and therefore a combined friction and key clutch is used to avoid undue shock on the shaft in starting.

Welding Equipment

In recent years much progress has been made with welding equipment and, with improved technique, it has contributed considerably to the development of welding. Much interest will be shown in the British Thomson-Houston Co. exhibit of the Thyratron control equipment for electric welding, which constitutes a development of great importance to the electric welding industry. Its use eliminates moving mechanical parts, while in conjunction with a suitable resistance welding machine it permits the welding of special alloys, coated steels and fine-guage materials hitherto thought impracticable ; also, the production speed of welding mild steel can be increased. The panel is shown applied to a welding equipment, and is complete with transformer and oil switch. These equipments are completely protected by a steel enclosing case, and can be supplied for controlling the heaviest K V A demands met with in resistance seam or spot-welding. The welding current can be made and broken up to 1,500 times per minute with the highest precision.

Controlling Spot Welding

In connection with spot welding where the number of welds per minute is controlled by the operator, the B.T.H. Thyratron timer can be used to control within very close limits the duration of the weld. This equipment is particularly adapted to the spot welding of mild steel and certain alloys where the speed of welding is not more than, say, 150 welds per minute, but where heat intensity of a short period is required for the actual welding process. It can be adjusted to give a welding time, of about $\frac{1}{10}$ sec. and the time once set by the operator, remains constant, and is not dependent upon manual dexterity.

The exhibits of the British Oxygen Co. are in three main groups, arranged to show the reclamation of worn parts by the oxy-acetylene process, including exhibits illustrating its use for preventing wear, and also for the deposition of materials for resisting wear, and for hard-surfacing; the applications of oxy-acetylene welding in the brewing, food, and chemical trades, which demonstrate the welding of non-ferrous metals—*e.g.*, copper, aluminium-bronze, stainless steels, and monel metal; and the advantage of oxy-acetylene welding in railway engineering, particularly in regard to the maintenance of the permanent way, the re-surfacing of worn crossings, and the use of the process for the attachment of traction and signal bonds.

Messrs. Holden and Hunt will show a new development; this is the No. 10 Auto Butt copper and non-ferrous welding machine which welds copper rods up to an area of ·5 sq. in., $\frac{3}{4}$ in. diameter, and has a capacity of 80 kw. The machine operates on the principle of a low ball-bearing mounted pivoted arm moving the welding head, giving a very sensitive action, which does away with slides that collect current, and gives no variation by friction, dirt or temperature. The upsetting pressure has micrometer adjustment, and will cover the range from $\frac{5}{16}$ in. diameter up to $\frac{3}{4}$ in., diameter. The welding is automatically controlled by a cut-off control for the completion and a press-button for the start of the weld, when the welding current is carried through a contactor switch. Eight heating speeds are provided to cover the machine range. Several other types of welding machines are exhibited by this firm.

It is appropriate to associate examples of welding with equipment, but the observant visitor will see several examples amongst the exhibits. Mention of a fusion-welded boiler drum by John Thompson (Wolverhampton), Ltd. may be made here. This boiler is 26 ft. long and has an inside diameter of 3 ft. 9 in.; the shell is $1\frac{9}{32}$ in. thick, and the ends $1\frac{11}{32}$ in. thick. The working pressure is 350 lb. per sq. in., and test pressure 530 lb. per sq. in. It is one of five drums for Thompson "Beta" water-tube boilers manufactured for the City of Glasgow Corporation. A set of radiographs of the seams of this drum, showing X-ray tests of all welds, is exhibited.

Another interesting exhibit by this firm is a stainless steel boiling pan, which is claimed to be free from weld decay, having a mild steel jacket entirely electrically welded. John Thompson, Ltd., are specialists in the welding of acid and corrosion-resisting metals for the food and chemical industries, and the vessel shown is representative of the high-class workmanship employed.

Degreasing Plant

The treatment of metal parts for the removal of oil, grease, or swarf is an operation which enters into many branches of industry from the cleaning of motor-car parts before repair to the preparation of a chemically-clean surface prior to plating or rust-proofing processes. I.C.I. degreasing plants are used for removing oil, grease, swarf, or polishing compounds from metal parts prior to overlaying, enamelling, cellulose spreading, electro-plating, lacquering, sand-blasting, bonderizing, packerizing, rust-proofing, etc. Trichlorethylene is employed as the solvent and the only other requirements are a heating device, supplies of cold water, and connection to a water drain. The plants have proved their value in many trades, each extension of use being met with adjustments and improvements in design. On the stand there will be shown working models of different types selected from the present range of stationary and continuous plants with a background of typically degreased articles.

Refractories

High-grade refractories are now recognised as essential in those industries which involve high temperature operations, and many firms are exhibiting specialities of this character. John G. Stein and Co., Ltd., for instance, are exhibiting high-grade firebricks, silica bricks, and sillimanite bricks for use in iron and steel works, boiler installations, gasworks, etc. Thomas Marshall and Co. are also represented, showing a wide range of heat-insulating products recently introduced by them. These include a representative selection of their well-known ladle and casting pit refractories for the steel industry, such as nozzles, stoppers, sleeves, and various types of runner bricks.

Amongst the insulation products of interest to readers are two grades of insulation brick, one a highly efficient refractory insulation brick with a high crushing strength, the second a super insulating brick also with high crushing strength, this latter feature, common to both bricks, being one that is held to be of considerable importance in the application of insulation.

Messrs. Gibbons (Dudley), Ltd., will be showing a full range of high-class refractory materials for all purposes. In addition to bricks and special shapes in fireclay and and high alumina materials, furnace engineers in particular will be interested in the range of super-refractories of carborundum, fused alumina and sillimanite, and also in the Gibbons H.T.I. refractory insulating brick. The latter, which has only recently been introduced, has a heat conductivity five times less than that of firebrick, and may be used without deterioration at temperatures up to 1,350° C. The attention of gas and coke-oven engineers is particularly directed to the firm's 95% silica goods, a special display of which is being made. Bricks, segmental retorts and coke-oven shapes in which a very high standard of quality has been reached, will be on view.

The Meltham Silica Fire Brick Co., Ltd. are showing representative samples of their well-known "highly converted" silica bricks and special shapes, such as are largely used in the gas and coke oven industry. A new feature of the display consists of several whole-piece sections of silica horizontal retorts, which is an innovation so far as this country is concerned, and will supply a long-felt want throughout the whole of the gas industry.

Testing Equipment

W. and T. Avery, Ltd., are showing a range of testing machines which include a 50-ton self-indicating universal testing machine, a five-ton self-indicating universal testing machine, a propeller balancing machine, a fatigue testing machine, a rapid hardness tester. Of these the fatigue testing machine is probably the most interesting. It is appreciated that the study of the fatigue of metals has been going on for many years and began when research was undertaken to ascertain the cause of certain breakdowns which could not be understood in the light of the then existing knowledge of the static strength of materials.

The form of test originally used by Wöhler, for testing by repeated bending in opposite directions is very much used to-day. A machine to carry out this test is generally known as a Wöhler machine. Such a machine is manufactured by Avery's, an advantage being that it produces similar stresses to those encountered by the majority of machine components. Another machine is designed to test metals by the application of alternating stresses with a different type of specimen. These two machines are available in a combined form.

Progress in Melting and Heat Treatment Furnaces*

The melting and heat-treatment of metals have developed into a more exacting science than was formerly considered possible. These developments are largely due to progress in metallurgy, and to economical factors which involve control of the application of heat and of furnace atmosphere. In this article some of the more recently constructed furnaces are briefly discussed.

Nitriding Furnaces Using Town Gas

THE case-hardening of steel by the nitriding process is now well known, and many furnaces have been designed especially for this process. A recent development of considerable interest is a furnace fired by town gas. This type of furnace was designed by the South Metropolitan Gas Company, one, illustrated in Fig. 13, being installed at the Laystall Motor Engineering Works, Ltd. This furnace has internal dimensions 25½ in. × 31 in. × 77½in. It is used for the nitriding of motor-car engine cylinder liners and other motor-car parts at the Laystall Works, who hold the sole licence in the London area for this kind of work, and undertake the nitriding of all kinds of parts required to stand up to hard wear or against corrosion.

The furnace is fired by means of luminous burners, and the operating temperature may be controlled between 485° and 530° C. according to requirements. The ammonia circulates inside a charge box, which is run into the muffle. The dished muffle door, shown in the illustration, is designed with a cross-bar and clamping device, so that the door can be firmly secured over the end of the muffle to prevent the ingress of products of combustion, which are taken up outside this door in order to keep that end of the muffle hot.

Fig. 13.—Nitriding furnace designed by the South Metropolitan Gas Company, and installed at the Laystall Motor Engineering Works, Ltd.

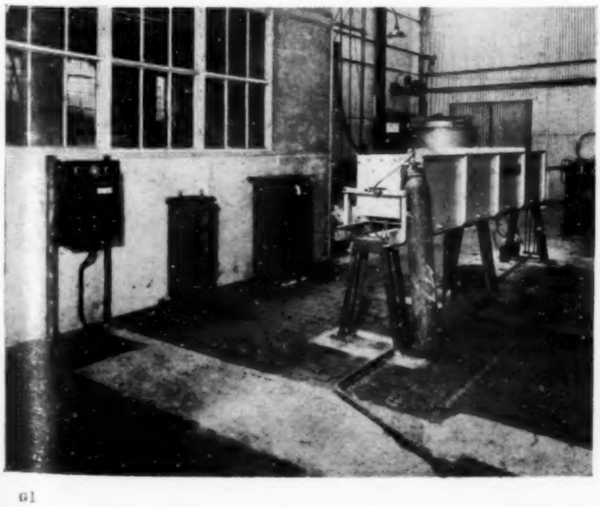
Continuous Furnace for Bright Annealing of Wire

The furnace illustrated in Fig. 14 consists of a long chamber, through which pass four ½-in. tubes of heat-resisting alloy, and along the top and bottom are fitted Wild-Barfield patented "Heavy-Hairpin" heating elements. The annealing temperature is 1,100° C., and this is controlled automatically by a thermo-electric controller. An excess temperature cutout is fitted, which safeguards the elements from overheating should, by any chance, the automatic controller fail to function correctly.

The wire to be annealed is drawn through the tubes continuously, and it is interesting to note that the output of wire is dependent only on the gauge of wire, and not on the heat input to the furnace; the larger the cross-sectional area of the wire, the greater the output. To produce a bright finish to the wire, the treatment is carried out in an atmosphere of hydrogen. Through tees, at the exit ends of the tubes, the gas is passed in, and glands are fitted at the entry ends to reduce the consumption of hydrogen. The use of this furnace is not limited to annealing, and the equipment can also be used for patenting steel wire and for other types of heat-treatment.

*Continued from January issue.

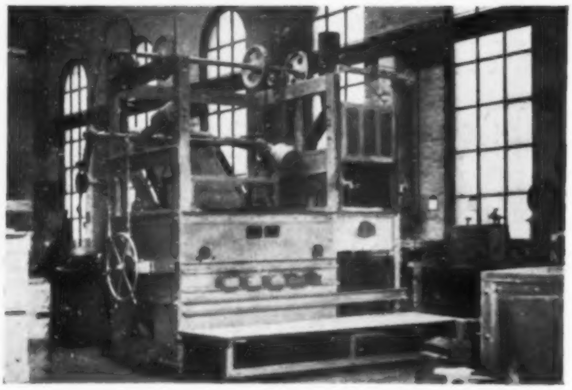
Fig. 14.—Continuous furnace for bright annealing wire—a development of Wild-Barfield Electric Furnaces, Ltd.



Heat-Treatment Furnaces for Non-Ferrous Alloys

The greatly increased demand for aluminium alloys in automobile and aircraft work has brought with it many advancements in furnace technique, perhaps the most notable being concerned with the development of large salt bath furnaces. Extremely accurate control and minimum end-to-end temperature variation are of paramount importance, but by the accurate positioning of machined burners, arrangements of flues, and protection of the pot, Messrs. Brayshaw have been able to obtain end-to-end temperatures of large salt bath furnaces within ± 0·006% at 500° C.

Such a furnace under construction at present is fitted with a pot 28 ft. 0 in. long, for the treatment of aluminium alloy sections for aircraft construction. Unless the top of the pot of such dimensions is effectively insulated, large radiation losses would occur, and in order to prevent this heat wastage, a carriage holding sectional covers is fitted.



By courtesy of Messrs. Brayshaw Furnaces & Tools, Ltd.
Fig. 15.—Large salt-bath furnace for the treatment of aluminium alloys.

These covers are designed to lift off the pot for loading and unloading by simple self-locking link motions, but under normal working conditions the covers sit on the top of the pot. Another feature is that the hot face of the cover is never presented to the furnace operator such as is the case with covers of the swinging lid type. Fig. 15 shows an oil-heated bath for duralumin, etc., with counter-balanced work tray compensated for loss in weight as work is immersed in liquid. Also work preheating chamber.

Other special problems have been raised by the comparatively recent adoption of the extrusion method of producing aluminium alloy tybes and other sections in long lengths, many of the alloys used requiring special treatment. Birmingham Electric Furnaces, Ltd., have installed several furnaces for this work, and up to 30 ft. 0 in. long, particularly noteworthy being those equipments with which provision is made for the rapid quenching of the material after its discharge from the furnace. These furnaces, one of which is shown in Fig. 16, generally have a cylindrical chamber, arranged horizontally with rails running through the entire length on which a movable carrier of suitable form may be operated to carry the charge.

Bright Annealing Furnaces

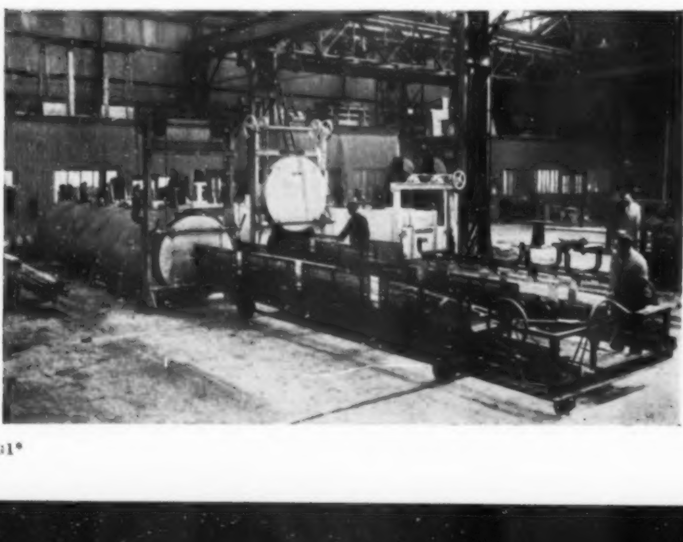
The subject of bright-annealing is too wide for adequate treatment in this article: a number of interesting installations have recently been made, however, including a continuous belt-conveyer type equipment for annealing non-ferrous sheets up to 4 ft. 6 in. in width and capable of an output of approximately one ton per hour—the exact figure depending upon the material being treated, the operating temperature, etc.

The belt-conveyer type furnace, Fig. 17, is, of course, adaptable to the handling of material in a wide variety of forms such as pressings, coils, strip, sheet, etc. For handling rod, tubes and other long sections continuously, however, a roller-hearth furnace is often more efficient since no power is required for the heating of wasteful material in the form of a conveyer belt. A noteworthy installation of this type which we have completed has an overall length of approximately 100 ft., including loading and unloading sections, and is operated up to an output of about 7 cwts. of non-ferrous tubes per hour.

The equipment illustrated in Fig. 18 is used for bright annealing nickel-chrome wire. It consists of one heating chamber with three bases. The chamber can be placed on any one of the bases by means of a travelling crane. Guide pillars are provided to centre the chamber, and a switch is fitted which prevents the elements being energised until the furnace has been lowered on to the floor. The chamber incorporates Wild-Barfield patented "Heavy-Hairpin" elements and excess temperaturecutout. Annealing of the wire is carried out at a temperature of 1,150° C. The method of operating the furnace is to place the chamber over the sealed retort covering the charge on the base. When the charge is up to the annealing temperature the heating chamber is removed and placed over the next retort and base, and so on. Hydrogen is passed into the retorts during the heating and cooling period, and natural cooling of the retorts is employed.

In this type of furnace, the heat stored in the insulation is saved, which naturally effects considerable economy in energy consumption, and increases the output for a given size of furnace.

Fig. 16.—Furnace for heat treating aluminium tubes and other long sections by Birmingham Electric Furnaces, Ltd.



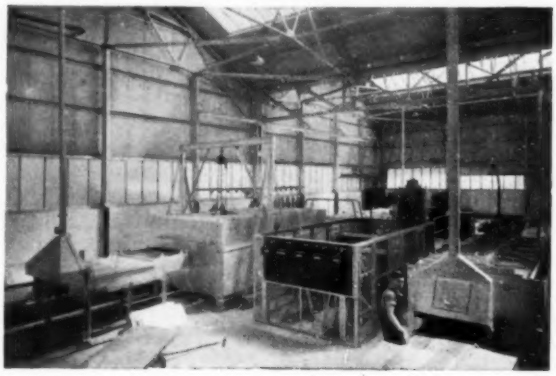


Fig. 17.—Continuous belt-conveyer type equipment for annealing non-ferrous sheets up to 4 ft. 6 in. in width.

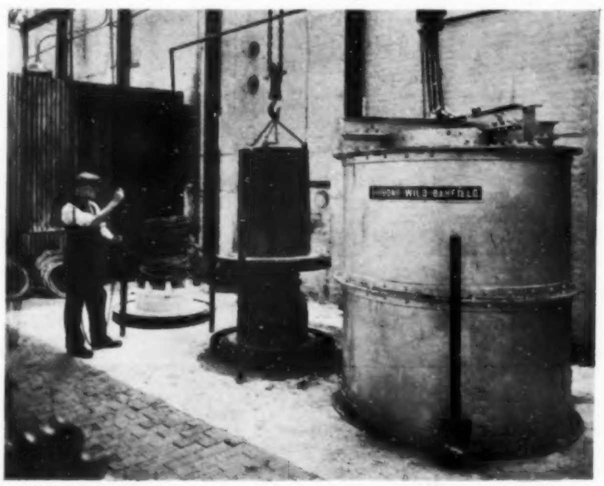


Fig. 18.—Equipment for bright annealing nickel-chromium wire by Wild-Barfield Electric Furnaces, Ltd.

Crucible Melting Furnace

The mechanisation of industry and modern developments in transport have stimulated the demand for high-grade light castings. Research has disclosed the value of the addition of special ingredients to foundry mixtures, and the foundryman has been compelled to tighten up his practice to meet the specifications of the metallurgist. The effect on castings of exposure of metal to furnace gases, oxidation, and the hundred and one other influences met in commercial melting practice has been carefully investigated, and it is now realised that many long-established methods are incapable of giving good results. Present-day means of testing are so perfect and so generally applied that a foundry manager cannot hope to retain the goodwill of his customers unless his furnaces can produce molten metal within very narrow limits of composition.

The melting and alloying of metals is in theory a very straightforward process. All that is necessary is means for raising the temperature to the degree required for the correct mixing and solution of the constituents of the alloy, plus sufficient superheat to enable it to enter the mould in a sufficiently fluid state. In practice, however, the metal is exposed to the disturbing influence of furnace atmosphere, which often imparts harmful impurities and causes oxidation and loss of valuable elements in the alloy.

Electric furnaces, in which there is no circulation of furnace gases, have been extensively adopted where suitable metallurgically and where a sufficiently cheap supply of energy is available. High-frequency furnaces have been successfully installed in several of the bigger Sheffield works specialising in alloy steels. Induction furnaces of the "liquid-secondary" type have proved very serviceable in non-ferrous rolling mills when the output is restricted to relatively few alloys within somewhat circumscribed limits of composition, but those who cater for a wide range of products continue to rely on fuel-fired furnaces.

The designer of furnaces can do a great deal to minimise the risk of metal being contaminated and wasted by the action of flame. Open-flame furnaces, properly designed and carefully operated, can and will continue to give good service in melting the cheaper, less volatile, and less oxidisable metals, but they must inherently fall far behind crucible furnaces for producing high-grade metal.

The Merits of Crucible Melting

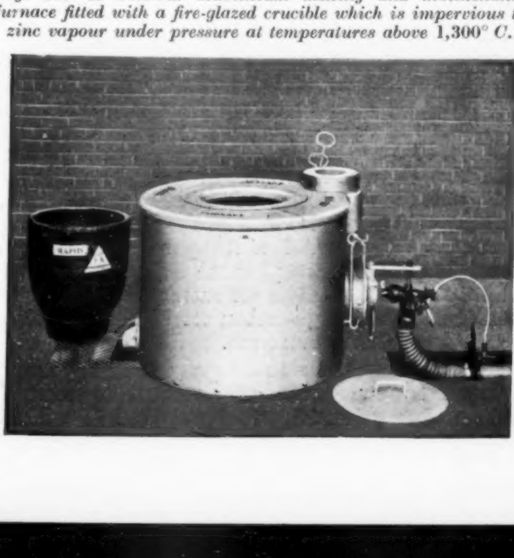
The merits of crucible melting are well known and thoroughly understood. In comparison with other methods of melting crucible practice of earlier days, then confined to pit fire melting, may have seemed laborious and expensive, but those responsible for the industry have of late years concentrated on the problem of modernising the process and increasing its scope. Mechanically operated crucible furnaces capable of melting as much as a ton of bronze are now in use. The durability of crucibles has been materially increased, and whereas not many years ago a life of 30 or 40 heats was considered quite good in a brass foundry, 100 and even up to 200 are nowadays obtained. This increase is mainly due to the use in crucible mixtures of electric furnace refractories, many of which offer great resistance to the destructive influences of fuel slags and metal fluxes. Means have also been devised for increasing their heat conductivity with substantial gain in fuel economy and reduction of the time required for melting. These achievements in the field of durability and thermal conductivity have gone far to remove any impression that crucible melting is inherently costly.

Developments in oil and gas firing have done much to stimulate crucible melting. It is impracticable to stoke and clinker coke-fired furnaces much in excess of half a ton capacity. No such difficulty exists with oil-firing, the operator having complete control of the heat supply by merely adjusting the oil or gas-air mixture at the burner. But pure nickel, Monel metal, alloy cast iron, cupro nickel, bronze, brass, and aluminium and its alloys are melted in oil- gas- or coke-fired tilting furnaces in sizes varying from 150 lb. to 1 ton capacity, and an illustration of a modern 400 lb. unit is shown in Fig. 19. This type of unit has been proved to meet present-day practice and requirements, which include rapidity of melting and complete protection of the metal by the crucible walls from gases and flame, which conduces to the production of high-quality alloys of rigid analysis with minimum metal loss, which in most cases is well under 1%.

Fig. 19.—A modern 400-lb. crucible tilting furnace which gives complete protection to the metal from gases and flame, and thus assists in the production of high-duty alloys.

The aluminium melting alloy industry has made great strides, due to the increasing use of this metal for aircraft and marine work. Many founders employ furnaces of the type illustrated in Fig. 20, which is a bale-out type aluminium melting and maintaining furnace, made in sizes from 50 lb./½-ton aluminium capacity. The same considerations apply in the case of these furnaces as to the tilting furnaces, but there is the important question of gas absorption. Until recently crucibles were undoubtedly permeable to gas, now the situation has been completely changed by the development of methods of producing a durable glaze on the pots. Modern fire-glazed crucibles have been shown to be impervious to zinc vapour under pressure at temperatures above 1,300° C., and their impermeability to oxygen is proved by the fact that they will withstand exposure at high temperature for weeks on end without appreciable oxidation of the graphite. The modern glazed plumbago basin gives its longest service when exposed to the highest furnace temperature consistent with the nature of the work to be done, and it is usually found to turn out more metal per day with less fuel than other types of containers.

Fig. 20.—A bale-out aluminium melting and maintenance furnace fitted with a fire-glazed crucible which is impervious to zinc vapour under pressure at temperatures above 1,300° C.



The Crapo Galvanising Process

By a Special Contributor.

As the result of experiments at the Indiana Steel and Wire Company's works at Muncie, Indiana, Mr. Frederick Martin Crapo took out an American patent, No. 1,501,887, dated July 15, 1924, to cover his ideas for "Protected metal and process of making it." By using a "chemical heat-treatment" he claimed to cheapen and shorten the processes of cleaning and annealing dead mild steel wire, and by producing a "superficial carbonising action" on the iron base body produce on it, when galvanised, an improved zinc coating which would not peel or flake off the wire when it was bent or twisted, which results were said "can not be obtained by ordinary galvanising."

A patent specification, No. 226,150. was granted in the United Kingdom, dated September 21st, 1925 (application date May 20th, 1924), to cover a "Process of zinc coating or iron and steel articles, and the product thereof." Diagrammatic details of the proposed layout for the continuous treatment of wire was reproduced in an article in *The Metal Industry* (London), on April 2, 1926, vol. 28, p. 315, and this shows the wire being heated to soften it in a bath of molten lead, at the outlet end of which is a layer of molten salts at a temperature of 1,200° to 1,300° F. The "advantageous mixture" of salts is quoted as containing 60% sodium cyanide, 20% sodium carbonate, and 20% sodium chloride, and it is claimed that "No period of immersion has proved too short, even down to 7 secs. (although 15 secs. is preferred" to produce the permeative effective of "something other than zinc," which increases the adherence of the subsequently applied zinc coating, whilst the parts of the article other than the surface remain substantially unchanged in physical, chemical and electrical properties.

The advantage of the process is that by cleaning and slightly roughening the skin of the wire the spelter actual becomes keyed on to the surface and produces a two-layer coating of macro-crystals of zinc which, when fresh, have a very attractive silvery appearance. The twists and bends which can be made in the wire without the coating becoming detached are remarkable, but it does not always "wrap on itself" without cracking, as was originally claimed. Owing to the great purity of the surface zinc coating the wire stands up well to the usually applied Preece dip test, which does not necessarily infer that the coating will also last well in all weather conditions, although it generally does where there is not excessive acid or salt in the air.

The disadvantages of the process is that it involves the use of a very poisonous substance (cyanide) in the molten state, in which it is readily volatile, and as this is constantly deteriorating to cyanate with the heat it is costly to keep renewing it, otherwise the cleaning action would not continue. Very careful adjustments have to be made in the control of the bath temperature and of the galvanising mechanism, also including the winding arrangements for the coils to ensure perfect mechanical stability throughout, otherwise the spelter coating is rough and irregular. A special bed of hot charcoal and oil must be maintained on the galvanising bath to ensure smoothness and lack of "drip" on the vertically emerging wire. Under certain conditions of damp atmosphere, charged with products of combustion, the wire develops "zinc rust," a white powder which spoils the appearance of the wire, and is referred to as mildew, and this falls off when the wire is being worked up and causes detrimental effects upon health. The process was originated for extra pure mild steel, and had to be modified to suit the British common steels, and for long it was inapplicable to high-carbon steels, although this lack has now been partly overcome.

Processes competitive to Grapo galvanising have been developed as the result of considerable research to enable perfect galvanising to be applied to wires other than dead mild steel, such as hard-drawn wire of 80 to 90 tons tensile strength, and even the highest tensile wire, which have beenpatented and drawn for inclusion in wire ropes, to withstand stress up to 125 tons per square inch. One such which meets all the requirements of the recent B.S.A. standard specification is "Silflex," which differs from Crapo in that it produces a micro-crystalline deposit of zinc of the surface of the wire, instead of the macro-crystals of Crapo wire. This has considerable advantages in that it does away with the need for expensive chemicals of a poisonous nature, and bends conformably with the wire so that it does not peel or flake just as is claimed for Crapo. This process has not been fully protected, as the provisional patent specification was not completed within the necessary period.

Another patented process was that of Mr. William Harold Potter, of Warrington, No. 345,598, of March 26, 1931, in which the fused salts on the top of the lead-annealing bath consist of the following mixture: Nitrolime (calcium cyananide), 10%; soda ash (sodium carbonate), 35%; and common salt (sodium chloride), 55%; and this is claimed to produce a nitrogenised skin on the wire which thus takes the spelter very cleanly, and produces the same or a similar effect upon the properties of the coating as does the Crapo process. The Potter process has been purchased and disused by the two sole licencees of the Crapo process in this country, where it has never been given an adequate trial to show its full merits.

High-strength Constructional Metals

On the recommendation of the Pittsburgh A.S.T.M. District Committee, the technical feature of the Society's regional meeting, to be held on Wednesday, March 6, in Pittsburgh, is to be a "Symposium on High-Strength Constructional Metals." In addition to Mr. Dean Harvey, Materials Engineer, Westinghouse Electric and Manufacturing Co., and Mr. Jerome Strauss, Vice-President in charge of Research and Development, Vanadium Corporation of America, assistance is being given by Mr. F. H. Frankland, Technical Director, American Institute of Steel Construction; Mr. R. A. Wilkins, Vice-President, Revere Copper and Brass, Inc.; and Mr. E. H. Dix, Jr., Chief Metallurgist, Aluminium Research Laboratories, Aluminium Company of America.

It is planned that the symposium will be held in two sessions, on the morning and afternoon of Wednesday, March 4. One of these sessions will be devoted to papers on non-ferrous metals and the other on steels. In selecting papers and authors, the programme committee has indicated its intention not to consider metals and alloys used in the construction of machinery, such as machine tools, airplane engines, automobile mechanisms, etc., but chiefly those employed for such constructional applications as buildings, bridges, ships, automobile and railway car bodies, airplane wings, tanks and the like. The papers will deal with chemical and physical properties, as well as manufacturing and fabricating properties, such, for example, as hot and cold working, welding, etc. It is intended that the papers will consider very briefly and only where deemed essential, matters concerned with design stresses, construction economy, and the like.

The papers to be presented include: "Alloys of Copper," by Mr. H. A. Bedworth; "Aluminium and Magnesium Alloys," by E. H. Dix, Jr.; 'Nickel and Its Alloys," by Mr. A. J. Wadhams; "Carbon and Low-Alloy Steels," by Mr. E. F. Cone; and "Corrosion Resisting Steels," by Mr. E. E. Thum. The authors of these papers will attempt to treat materials coming within the general classification of the main subject, and include not only those which are already firmly established industrially, but others which are in the commercial stage of development, although perhaps not yet in widespread use. This latter object is of importance in outlining the trend of the immediate future.

Business Notes and News

Safety and Health in the Foundry Industry

With a view to making more effective the work the American Foundrymen's Association has carried on for a number of years, on plant safety, good housekeeping, and protection of foundry workers, a Safety and Hygiene section has been organised to accomplish the following purposes: To determine further the extent of hazards to safety and health in the foundry industry; to study causes of hazards and methods of prevention, and to provide further protection to workers against exposure. Co-operation with other centralised agencies of industry confronted by similar problems, in assembling and making available information on this subject. Co-operation with public health agencies, insurance carriers, and the medical profession in forwarding health measures. Assisting in standardisation of dust elimination equipment and improvement of shop operating conditions in the foundry industry through active educational work. Promoting standards for dust elimination and control equipment, in co-operation with agencies of the manufacturers of such equipment. Giving encouragement by active means where enactment of equitable and fair compensation laws is sought in industrial states.

Mr. E. O. Jones, for the past three years Consultant of Industrial Relations Bureau of the National Founders' Association, has been made Director of this Safety and Hygiene section, and will have his office at the headquarters of the American Foundrymen's Association, 222, West Adams Street, Chicago, U.S.A.

New Orenburg Copper Mine Nears Completion

An annual production of 25,000 tons of copper, in addition to large quantities of sulphur, is expected when the new Pyatakov Copper-Chemical Combine, at Blyeva, midway between Orenburg and Orsk, Orenburg Province, commences operation some time during the year.

Despite extremely stubborn geological conditions, extensive mechanisation together with Stakhanov methods enabled workers there to maintain a steady rate of progress in tunnel driving of five and more metres a day, surpassing the best European records for this class of work. The main artery of the mine, a gangway 1,840 metres long, is claimed to be the longest in the Soviet Union.

Blyeva ores contain copper, sulphur, gold and silver, and occur in compact beds measuring 150 metres in length, and 70 to 80 metres in width, in contrast to the Ural ores which are widely distributed in smaller beds and outcroppings.

Road Vehicle Springs—Their Design, Materials and Manufacture

An interesting and informative book on road vehicle springs has been issued by Samuel Fox and Co., Ltd., associated with the United Steel Companies, Ltd., which will prove invaluable to engineers of bus and trolley-bus operating companies and municipal authorities. The first section deals with spring design in relation to comfort, with sub-sections on the prevention of pitching, cobblestoning, roll, etc. The next section is concerned with safety and deals with spring design in relation to safety, in which stresses due to braking, potholes, etc., materials, etc., are discussed.

The remainder of the book provides useful information on various matters of interest to the bus designer and operator, such as location of spring leaves, attachments of springs to vehicles, spring manufacture and maintenance, special features of Fox Springs, types of Fox Road Vehicle Spring, and concludes with a Technical Supplement which provides new and simple methods of solving problems which confront most chassis designers.

The book is fully illustrated by photographs to show (*a*) the wide range of Fox Road Vehicle Springs (*b*) the interesting processes of manufacture and (*c*) actual applications of Fox springs to modern road vehicles of a variety of types and sizes. The quality of the photographs used is illustrated by the fact that several were shown at the 1935 Summer Exhibition of the Professional Photographer's Association. It is produced in an excellent form and those desiring copies should not delay their application to Publicity Department, the United Steel Co., Ltd., 17, Westbourne Road, Sheffield, 10.

Soviet Steel Output Rises by Three Million Tons

In 1935 the Soviet Union smelted 20% more iron than in 1934, the output being increased from 10·5 million tons to 12·5 million tons. The increase in the production of steel and rolled metal has been still greater. The output of steel increased in 1935 by 30% (from 9·6 million tons to 12·6 million tons). A significant fact about these figures is the excess of steel production over pig-iron. The previous year the reverse had been the case.

The industry has progressed not only in the quantity of its output, but in quality also. In 1935 new forms of section metal have been rolled. Manganese-copper steel and vanadium iron, varieties of metal not previously manufactured in the Soviet Union are now being produced.

Shortage of Pig Iron

There is acute shortage in supplies of pig iron, and it seems likely that arrangements may be made for suitable imports until production can be adjusted to demands by the operation of further blast furnaces. Present conditions are causing concern to consumers, who fear that inability to secure supplies of iron may prejudicially affect their production programmes, while producers themselves are disturbed by the pressure of demand which they cannot satisfy.

It is not possible to determine when additional blast furnaces will be ready for operation, but efforts are being made to start additional plant, this, however, will take considerable time. With stocks of iron exhausted and customers anxious to increase their consumption of raw material, the situation is becoming steadily worse. Users of foundry iron are complaining strongly of the difficulty in getting full deliveries from Teesside, while merchants are losing valuable export business, because manufacturers will not quote for overseas sale.

No iron is available for sale, the whole of the output for some time ahead having been sold. Prices have little significance, and makers maintain the minimum fixed rates which have obtained recently, but no transactions are recorded.

New Cardiff Works

The new Cardiff works of Guest Keen Baldwins Iron and Steel Co., Ltd., recently opened, are probably the most advanced of their kind in Europe. The plant consists of a coal washery, two batteries of coke ovens and by-product plant, three blast furnaces, a melting shop comprising one 600-ton metal mixer, three 200-ton basic open-hearth tilting furnaces and two fixed furnaces of 80-ton capacity. In addition, there is a cogging mill, continuous sheet bar and billet mill and a light bar mill.

When fully running 8,000 tons of coal per week will be carbonised in the coke ovens, and the three blast furnaces will produce over 10,000 tons of pig iron per week. The steelworks are designed to supply the rolling mills with sufficient steel ingots to enable an output of 6,500 tons per week of billets, bars and light sections to be produced. The reconstruction of the steel works has been accomplished in the very short space of 19 months.

Further Developments at Vickers Works

An important statement regarding plans for further development and improvement of the Vickers Works was made at a recent dinner by Mr. A. B. Winder, Director and General Manager of the English Steel Corporation, Ltd. Further reconstructions and extensions put before the Board by the Management have been accepted and an additional grant of £750,000 has been sanctioned. Much reconstruction work has already been carried out at the Vickers Works especially since the reorganisation scheme was put into operation a few years ago, the results of which have proved very sucessful. During this year astounding progress has been made and there is every prospect of the works remaining busy for some time.

It is noteworthy that in three years the Vickers Works increased its number of employees by 40%, and the wages bill increased by 79% in the same period, as many men who were on short time are now fully employed. The increase in individual earnings is 28%. The Directors of the English Steel Corporation, Ltd., showed considerable courage at a time when expenditure on reconstruction had only doubtful possibilities. Thanks to their foresight, however, the Company has made remarkable progress and now look upon big jobs as a matter of course. The new expenditure sanctioned indicates the Company's desire to anticipate further demand and to continue the fight to effect still further economics in production.

MARKET PRICES

ALUMINIUM.

98/99% Purity		£100 0 0

ANTIMONY.

English		£73 0 0
Chinese		62 0 0
Crude		31 0 0

BRASS.

Solid Drawn Tubes	lb.	9¾d.
Brazed Tubes	„	11¾d.
Rods Drawn	„	8⅝d.
Wire	„	7¾d.
*Extruded Brass Bars	„	4¼d.

COPPER.

Standard Cash		£35 1 3
Electrolytic		39 5 0
Best Selected		38 5 0
Tough		37 15 0
Sheets		66 0 0
Wire Bars		39 10 0
Ingot Bars		39 10 0
Solid Drawn Tubes	lb.	10½d.
Brazed Tubes	„	10½d.

FERRO ALLOYS.

‡Tungsten Metal Powder	lb.	0 3 3
‡Ferro Tungsten	„	0 3 0
Ferro Chrome, 60-70% Chr. Basis 60% Chr. 2-ton lots or up.		
NOMINAL: 2-4% Carbon, scale 11/- per unit	ton	29 15 0
NOMINAL: 4-6% Carbon, scale 7/- per unit	„	22 7 6
NOMINAL: 6-8% Carbon, scale 7/- per unit	„	21 12 0
NOMINAL: 8-10% Carbon, scale 7/- per unit	„	21 12 0
§Ferro Chrome, Specially Refined, broken in small pieces for Crucible Steelwork. Quantities of 1 ton or over. Basis 60% Ch. Guar. max. 2% Carbon, scale 11/0 per unit	„	33 10 0
Guar. max. 1% Carbon, scale 12/6 per unit	„	36 5 0
§Guar. max. 0·7% Carbon, scale 12/6 per unit	„	37 5 0
‡Manganese Metal 97-98% Mn.	lb.	0 1 2
‡Metallic Chromium	„	0 2 5
§ Ferro-Vanadium 25-50%	„	0 12 8
§ Spiegel, 18-20%	ton	7 10 0
Ferro Silicon—		
Basis 10%, scale 3/- per unit	ton	6 5 0
20/30% basis 25%, scale 3/6 per unit	„	8 17 6
45/50% basis 45%, scale 5/- per unit	„	12 5 0
70/80% basis 75%, scale 7/- per unit	„	17 17 6
90/95% basis 90%, scale 10/- per unit	„	28 17 6
§ Silico Manganese 65/75% Mn., basis 65% Mn.	„	12 17 6
§ Ferro-Carbon Titanium, 15/18% Ti	lb.	0 0 4½
Ferro Phosphorus, 20-25%	ton	20 0 0
§ Ferro-Molybdenum, Molyte	lb.	0 4 6
§ Calcium Molybdate	„	0 4 2

FUELS.

Foundry Coke—		
S. Wales	—	1 6 6
Scotland	—	1 10 0
Durham	1 1 6 to	1 3 0
Furnace Coke—		
Scotland	—	1 5 0
S. Wales	—	1 0 6
Durham	—	0 19 6

GUN METAL.

*Admiralty Gunmetal Ingots (88 : 10 : 2)		£58 0 0
*Commercial Ingots		42 0 0
*Gunmetal Bars, Tank brand, 1 in. dia. and upwards	lb.	0 0 9
*Cored Bars	„	0 0 11

LEAD.

Soft Foreign		£15 7 6
English		17 10 0

MANUFACTURED IRON.

Scotland—		
Crown Bars, Best		£10 5 0
N.E. Coast—		
Rivets		10 10 0
Best Bars		10 2 6
Common Bars		9 5 0
Lancashire—		
Crown Bars		9 12 6
Hoops	£10 10 0 to	12 0 0
Midlands—		
Crown Bars		9 12 6
Marked Bars		12 0 0
Unmarked Bars	from	7 5 0
Nut and Bolt Bars	£7 10 0 to	8 0 0
Gas Strip		10 12 6
S. Yorks—		
Best Bars		10 15 0
Hoops	£10 10 0 to	12 0 0

PHOSPHOR BRONZE.

*Bars, "Tank" brand, 1 in. dia. and upwards—Solid	lb.	9d.
*Cored Bars	„	11d.
†Strip	„	11d.
†Sheet to 10 W.G.	„	11½d.
†Wire	„	1/0⅛
†Rods	„	11½d.
†Tubes	„	1/1¾
†Castings	„	1/-

†10% Phos. Cop. £30 above B.S.
†15% Phos. Cop. £35 above B.S.
†Phos. Tin (5%) £30 above English Ingots.

PIG IRON.

Scotland—		
Hematite M/Nos.		£3 13 6
Foundry No. 1		3 16 6
„ No. 3		3 13 0
N.E. Coast—		
Hematite No. 1		3 11 0
Foundry No. 1		3 12 6
„ No. 3		3 10 0
„ No. 4		3 9 0
Silicon Iron		3 10 0
Forge		3 9 0
Midlands—		
N. Staffs Forge No. 4		3 11 0
„ Foundry No. 3		3 15 0
Northants—		
Foundry No. 1		3 15 6
Forge No. 4		3 8 6
Foundry No. 3		3 12 6
Derbyshire Forge		3 11 0
„ Foundry No. 1		3 18 0
„ Foundry No. 3		3 15 0
West Coast Hematite		4 6 0
East „ „		3 11 0

SWEDISH CHARCOAL IRON AND STEEL.

Pig Iron Kr. 106	
Billets Kr. 240-310	£12 7 6-£16 0 0
Wire Rods Kr. 290-340	£15 0 0-£17 10 0
Rolled Bars (dead soft) Kr. 200-220	£10 6 0-£11 7 0
Rolled Charcoal Iron Bars Kr. 290	15 0 0

All per English ton. f.o.b. Gothenburg.
Converted at £1 = Kr. 19.40 approx.

SCRAP METAL.

Copper Clean	£28 10 0
„ Braziery	25 0 0
„ Wire	—
Brass	19 0 0
Gun Metal	27 0 0
Zinc	8 0 0
Aluminium Cuttings	74 0 0
Lead	13 10 0
Heavy Steel—	
S. Wales	2 5 0
Scotland	2 17 6
Cleveland	2 17 6
Cast Iron—	
Midlands	2 10 0
S. Wales	2 17 6
Cleveland	3 2 6
Steel Turnings—	
Cleveland	2 0 0
Midlands	2 2 0
Cast Iron Borings—	
Cleveland	1 7 6
Scotland	1 17 6

SPELTER.

G.O.B. Official	—
Hard	£12 0 0
English	15 12 0
India	13 0 0
Re-melted	13 5 0

STEEL.

Ship, Bridge, and Tank Plates	
Scotland	£8 15 0
North-East Coast	8 15 0
Midlands	8 17 6
Boiler Plates (Land), Scotland	8 10 0
„ „ (Marine) „	—
„ „ (Land), N.E. Coast	8 10 0
„ „ (Marine) „	8 17 6
Angles, Scotland	8 7 6
„ North-East Coast	8 7 6
„ Midlands	8 7 6
Joists	8 15 0
Heavy Rails	8 10 0
Fishplates	12 10 0
Light Rails £8 10 0 to	8 15 0
Sheffield—	
Siemens Acid Billets	9 2 6
Hard Basic £6 17 6 to	7 2 6
Medium Basic £6 12 6 and	7 0 0
Soft Basic	5 10 0
Hoops £9 10 0 to	9 15 0
Manchester	
Hoops £9 0 0 to	10 0 0
Scotland, Sheets 24 B.G.	10 10 0

HIGH SPEED TOOL STEEL.

Finished Bars 14% Tungsten	lb.	2/-
Finished Bars 18% Tungsten	„	2/9
Extras		
Round and Squares, ½ in. to ¼ in.	„	3d.
Under ¼ in. to 3/16 in.	„	1/-
Round and Squares 3 in.	„	4d.
Flats under 1 in. × ⅜ in.	„	3d.
„ „ ⅛ in. × ¼ in.	„	1/-

TIN.

Standard Cash	£208 15 0
English	209 5 0
Australian	209 5 0
Eastern	207 5 0
Tin Plates I.C. 20 × 14 box	18/9

ZINC.

English Sheets	£22 17 0
Rods	27 5 0
Battery Plates	—
Boiler Plates	—

*McKechnie Brothers, Ltd. Feb. 8 † C. Clifford & Son, Ltd., Feb. 8 ‡ Murex Limited, Feb. 8

Subject to Market fluctuations. Buyers are advised to send inquiries for current prices.

§ Prices ex warehouse, Feb. 8